SEPTEMBER 1984 VOL. 2, NO. 3 $3.95

FOR IBM PERSONAL COMPUTER USERS

TECH JOURNAL

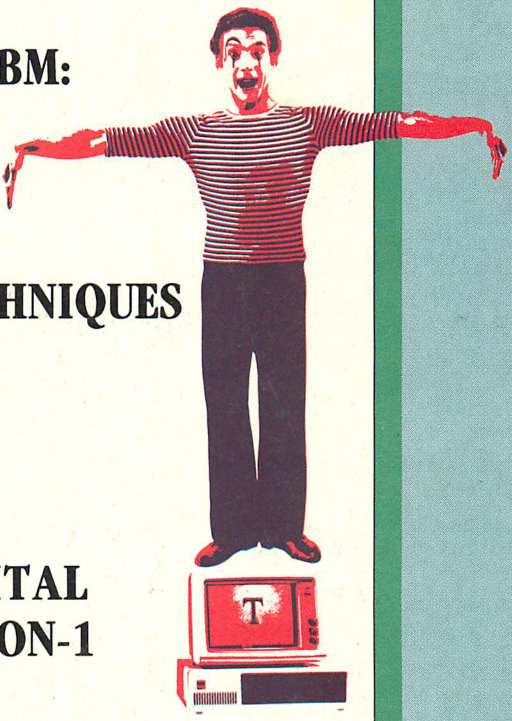
HIGH-TECH MIMICRY

Ten terminal-emulation packages for the IBM PC

OMNINET FROM CORVUS: GRAND OLD MAN OF NETWORKS

[redacted]

TWO PRINTERS FROM IBM: COLOR GRAPHICS AND PC COMPACT



ADVANCED MACRO TECHNIQUES ON THE IBM PC

AN APL TUTORIAL

FROM ANALOG TO DIGITAL ON THE PC WITH DASCON-1

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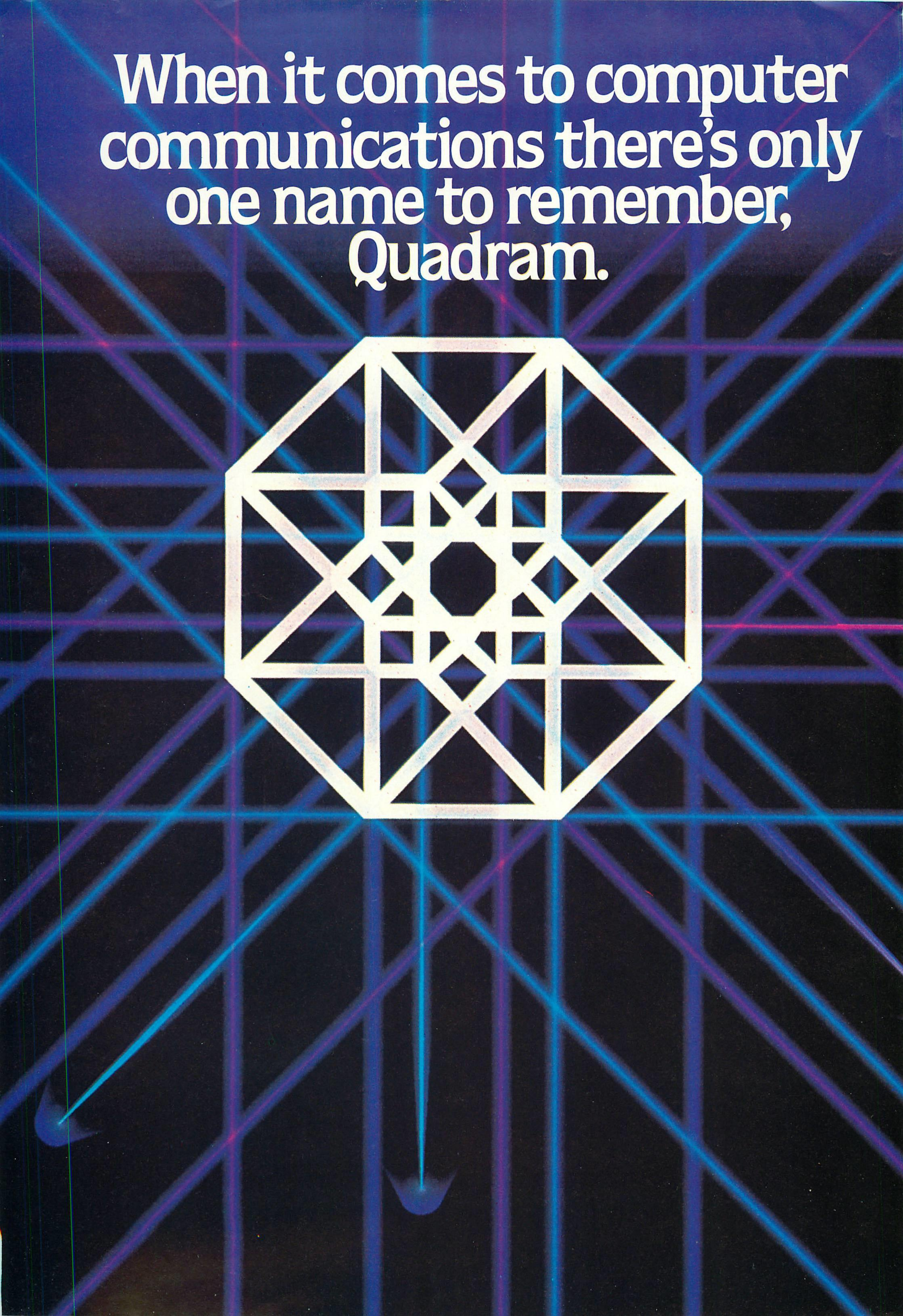
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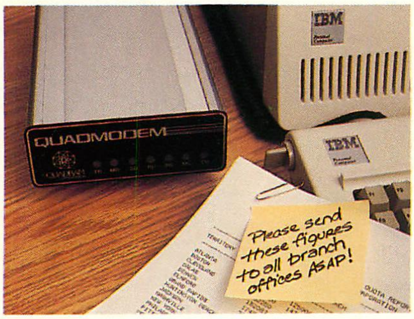

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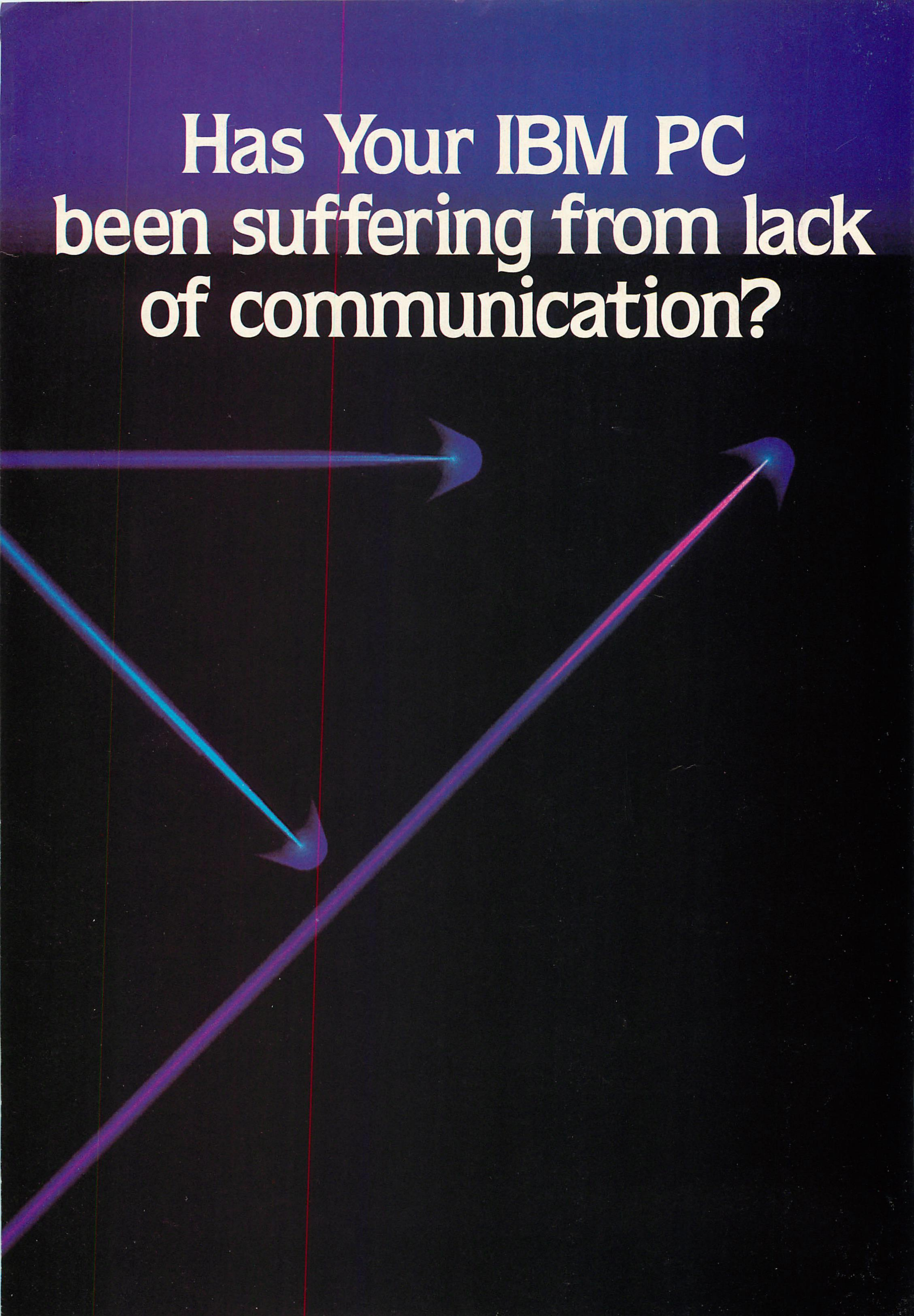
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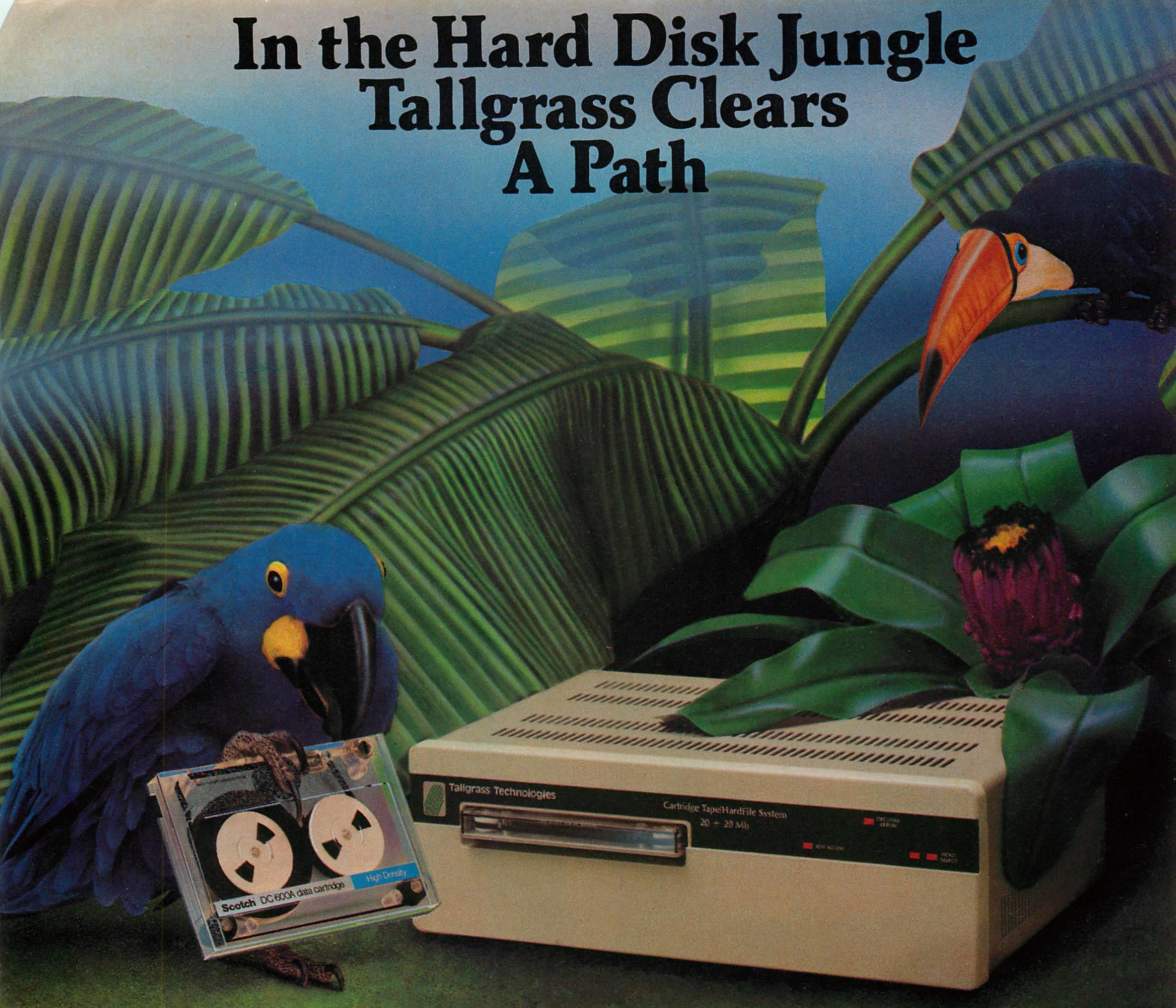

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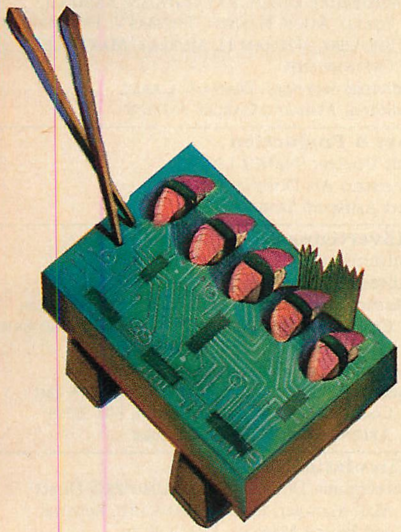

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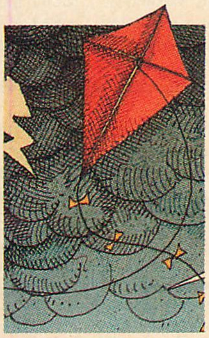

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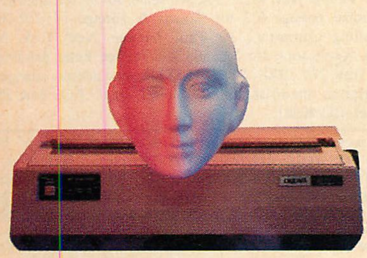

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Printer Standards

After more than fifteen years of inexpensive printers, we still have weak standards.

The computer industry's record of setting and then sticking to standards is worse than my record of getting home on time. My wife can tell you how terrible that must be.

One reason for this is just plain stubbornness on the part of the manufacturers. I mean, give somebody just a few unused codes in the ASCII set and WHAM!, they've got a way to accomplish some special, proprietary function. The thought of doing what everyone else is doing is anathema: after all, the whole point is to offer greater features or to deliver some gimmick.

The industry has done quite well in some ways. From an electronic point of view, we benefit each day from numerous standards that we probably take for granted. The RS-232-C standard is so strong that we can buy an adapter, cable, and modem with 99.44-percent certainty that it will all plug together and work. The 5¼-inch floppy drive has become so standardized that add-in drives can be purchased from mail-order sources with confidence. A wide selection of display monitors uses either the composite or the RGB standard. Most printers will interface either to the so-called Centronics parallel interface or to an RS-232-C serial port.

Beyond the electrical interface is the question of how a device attached via one of these interconnect standards behaves. Most computer systems operate serial ports properly and consistently. Displays usually differ only in resolution, and so far it has been easy and economical to build displays that meet the resolution requirements of small computers. Diskette drives have been more complicated, but there is a program for the PC that can read and write about 40 different formats and convert data from one format to another, so the problem of incompatible systems can be solved.

Printers, on the other hand, don't conform as well. Actually, they don't conform *at all*. It's not only irritating, it's confusing.

Most printers available today, whether dot matrix, daisy wheel, or some other technology, are able to print at least a subset of 7-bit ASCII characters that I will refer to as the 96-character set. It includes the numerals, upper- and lower-case letters, common punctuation marks, and a few control characters such as line feed and carriage return. This character set is sufficient to meet the needs of most users when it comes to programming or word processing. At this level, most printers can be said to conform to a standard.

That is, however, the standard of 15 years ago. The revolution in dot matrix technology has spawned a generation of printers with extended character sets, multiple type fonts, multiple pitch sizes, print enhancements, and (this is the rub) *graphics* capabilities. Not only do these printers support a full 256 characters (8-bit ASCII), some provide *several* full 256-character sets.

Things got rolling with the TRS-80 Model I. It is clear in retrospect that someone saw how the low resolution of the Model I's display could be duplicated with a special block-character set built into the printer. Soon, Epson began delivering printers that included this character set. Epson also provided a dot-by-dot graphics capability, and the era of the contemporary personal computer printer was born. Epson's MX series of printer became something of a standard.

Now that's a good story. Unfortunately, another company came along with *its* improvement and mucked things up. Have you guessed who? Yup. IBM.

At first, IBM kept pretty close to the standard. The first model of the IBM PC printer, an MX-80 in disguise, even included the TRS-80 graphics character set, which IBM called the "ASCII-Graphic Matrix." Just as IBM announced its printer, however, Epson began to include the Graftax-Plus ROM as a standard feature in its models. IBM followed with the Personal Computer Graphics Printer. It was at this point that IBM made a proprietary decision.

IBM's new ROM removed the TRS-80 block graphics entirely in favor of a representation of the IBM character set. The new printer was thus capable of printing almost every character that could be displayed on the screen, with some limitations. In addition, the IBM printer was almost, but not quite,

compatible with the Graftrax-Plus standard. This new IBM printer was thus quite attractive for the user who desired an integrated system.

Unfortunately, it was announced at about the same time the next wave of the Epson product line, the FX family, emerged. The FX, with its greater speed and enhanced capabilities, was an attractive choice, but it did not provide the IBM character set.

Meanwhile, a Japanese printer invasion was underway. I hope you are not surprised to learn that these printers conformed to no standard. To be fair, some did match the Epson specifications, but most did it their own way, and none included the IBM-style character set.

That leaves us with a mess. As PC owners, we would like to have printers with all the nice, new features, but it is also handy to have a machine that matches properly with the computer. There seems to be no way we can have IBM capability *and* the most up-to-date features in one machine, although no technological barriers prevent it. Also, as software developers, we would like to write applications and systems software that are independent of printer hardware yet take advantage of the more powerful features, particularly graphics, that the printers can offer.

I think it's about time for a stronger standard to emerge. The TI 855 printer demonstrates that such a standard is possible. It includes an Epson-like mode as well as a Diablo 630 emulation. Font cartridges are already available. Forthcoming options for the machine are supposed to provide IBM compatibility and loadable character-set definitions.

Printers need to provide power and flexibility. More important, they need to become as interchangeable as stereo components. I believe that such standardization would have a far-reaching effect on the useability of small computers, to the long-term benefit of us all.

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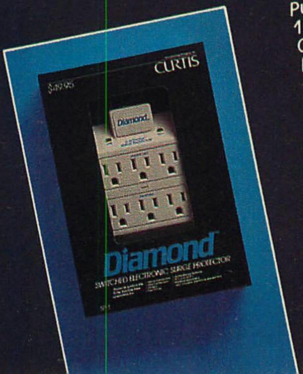

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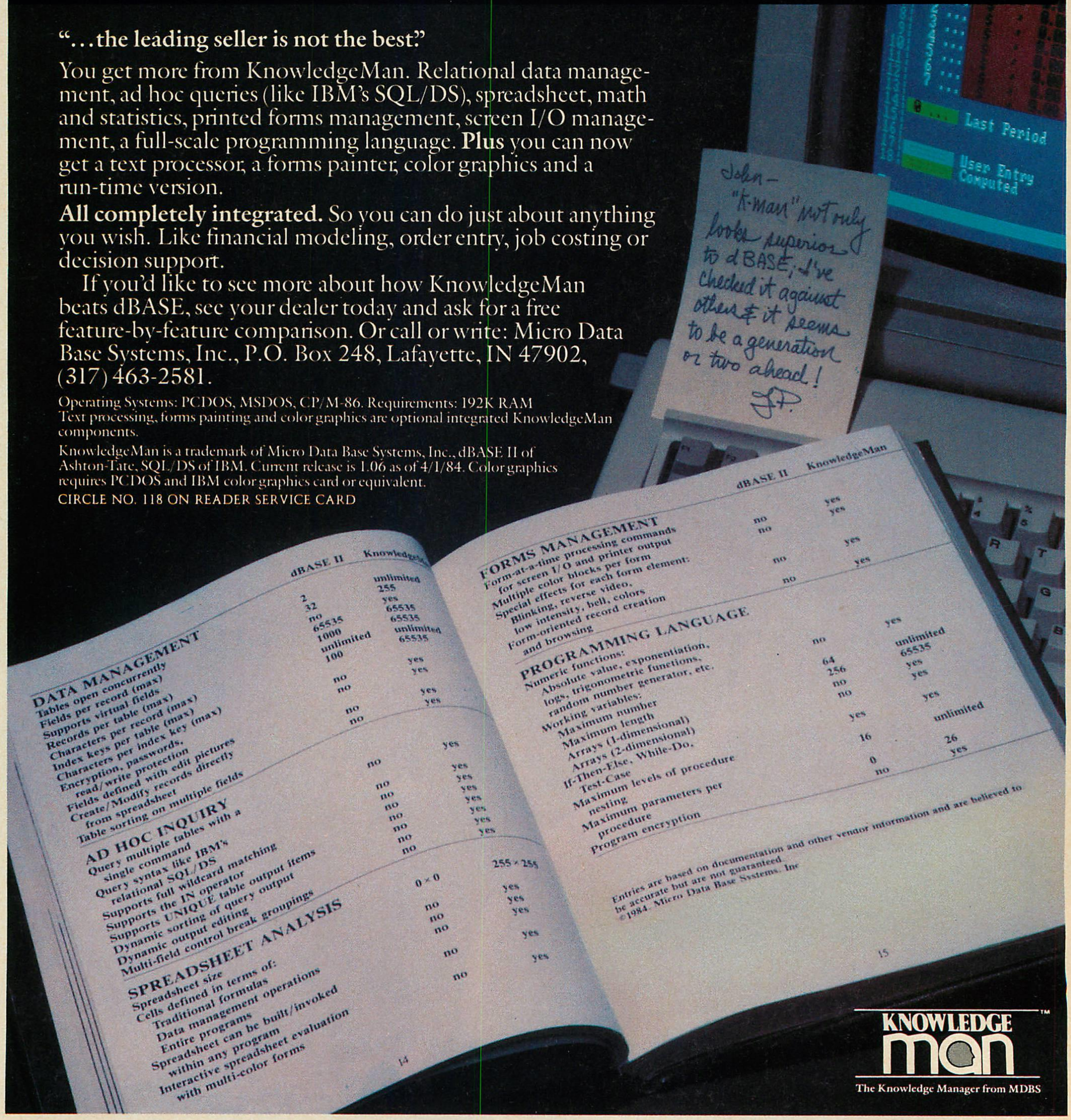

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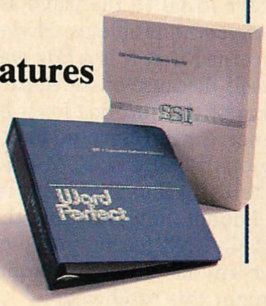

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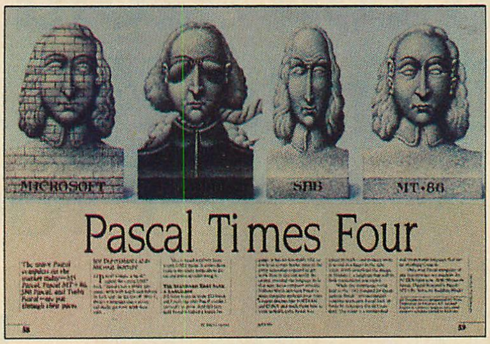

Patching Things Up

The article "Time on Your Hands" (Bob Smith and Tom Puckett, May 1984, page 146) addresses a problem I would dearly like to put to rest. I have crashed my system many times with the DEBUG TRACE command as discussed in that article. Of course, I am reluctant to install a patch in DEBUG that I cannot understand. I may then suffer even worse problems. Your article has solved nothing for me.

I use DOS 2.0, and I refer only to the patch shown for that version of DEBUG on page 158. The code to resolve the problem is inserted at offset 2E80. It appears that the authors believe that this is beyond the end of the code loaded from DEBUG.COM. I infer this from the fact that the contents of CX, which contains the number of bytes loaded, is 2E80, and they proceed to increase the length by the length of their added code. In fact, the code is placed on top of DEBUG. Since COM files are loaded starting at offset 0100, the length 2E80 runs out to 2F7F. If the authors meant to replace part of DEBUG, there is no need to increase its length. If they meant to put their code at the end, it is in the wrong place. In any case, it is not sufficient to place the patch at the end since that is the location of the new program segment built by DEBUG.

I have installed the patch as shown and observed no problems. However, I am concerned that it is a bug waiting to show itself. Because of the apparent confusion of the authors, I can have no confidence. Since I have no idea what this region of DEBUG.COM is for, I cannot tell whether a problem is likely or not. I doubt, however, that this part of DEBUG.COM has no purpose.

Can anyone find an appropriate place to put this patch code?

Robert Duncan Scott
Cincinnati, OH

R.D. Scott's confusion is understandable and is my fault because I overlooked the effect of the PSP's offset. The result is that I unnecessarily increased DEBUG's length—our patch actually fits within the extra space at the end of DEBUG. However, this error is harmless.

A more detailed analysis of DEBUG's memory usage shows the following: DEBUG is loaded at offset 100h in a certain segment. Its nominal end is 2E80h bytes later at 2F7Fh. Its internal stack top is at 2AE2h with the bytes above there to 2CDDh taken up mostly by static data (message text, etc.). The large area from 2CDEh to 2F0Fh is used as a temporary work area (I don't know why it's so large). The new PSP built by DEBUG begins at 2F10h. Again, the nominal end of the program is at 2F7Fh—beyond the point of the new PSP, suggesting that the program's length was rounded up (perhaps to a multiple of 128 bytes—the usual size of a Disk Transfer Area).

Our patch appears from 2E80h to 2EB1h—toward the end of the temporary work area. It originally took up more of the space toward 2F10h, but subsequent changes reduced it to the current size. I decided not to relocate the final version of the patch closer to the new PSP, as that accomplished little. The beginning address of the patch and the program length are coincidentally equal. All address calculations were done based upon snuggling up to the beginning of the new PSP at 2F10h. The change in length of the patched program was an error—though harmless.

Considerable usage of the patched program has shown that no part of DEBUG tramples on the patched area, although that can't be taken as proof. As with most patches to code for which no source is available, one can never be absolutely sure—only confident to a high degree, which we are.

—Bob Smith

3-D Question

I have been exposed to BASIC off and on over the years— since about the time that it left Dartmouth, in fact. I think that I have learned BASIC and then forgotten it about four different times.

In all that time, I have never seen a program equal to the one published in the May issue of *PC Tech Journal* ("3-D Graphics for the IBM PC," Jay Mallin, page 36), in regard to concept, documentation, clarity, and even listing format. I have used a similar program, supplied by Digital Research for DR. LOGO, in my school classes, but because of the lack of documentation I never really knew what was going on. (Your program is orders of magnitude faster than the DR> LOGO version.)

Congratulations on a fine article.

I have been planning for some time to add an 8087 chip to my PC, and after reading your article I made the plunge and have placed an order for one. Is it possible, with the 8087, to produce a THREED that actually rotates an object while you watch?

Sam Starr
Rose Valley, PA

To modify the THREED program to rotate objects while you watch, you would have to make the the program divide rotations into small increments—maybe one degree—and rapidly move through them. Simply plugging in an 8087 won't provide the speed you need, since IBM's interpretive BASIC does not use the chip. But if you compile the program with a BASIC compiler that makes use of the 8087, it will probably provide the effect you are after. How well it works will depend partly on the speed of the line-drawing and other graphics routines the compiler provides.

—Jay Mallin

We just made IBM's PC/XT 20 times more powerful.

Introducing Dragon's New 65 Mb and 140 Mb Hard Disk Drives.

What makes Dragon the best hard disk drive for the IBM PC, XT, and compatibles?

Larger Storage Capacity…

With 65 Mb of on line storage, the SP-65 holds up to 57 Mb of formatted data. The SP-140 stores up to 121 Mb of formatted data with a total capacity of 140 Mb. No 5¼ inch Winchester stores more than these new Dragon Disks.

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The SP-65 and SP-140 come with hard disk, controller, host adapter, power supply, cables, and chassis. Both systems are compatible with PC-DOS and MS-DOS.

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Additional options include: Dual drives with up to 280 Mb of on line storage (or 260 Mb formatted). Streamer tape and random access back up. 90 day warranty. Responsive technical help.

For more information, contact Dragon Industries, 35 Main Street, Hopkinton, Mass., 01748. (800) 824-8006 or (617) 435-4183 in Massachusetts. Distributor and OEM inquiries invited.

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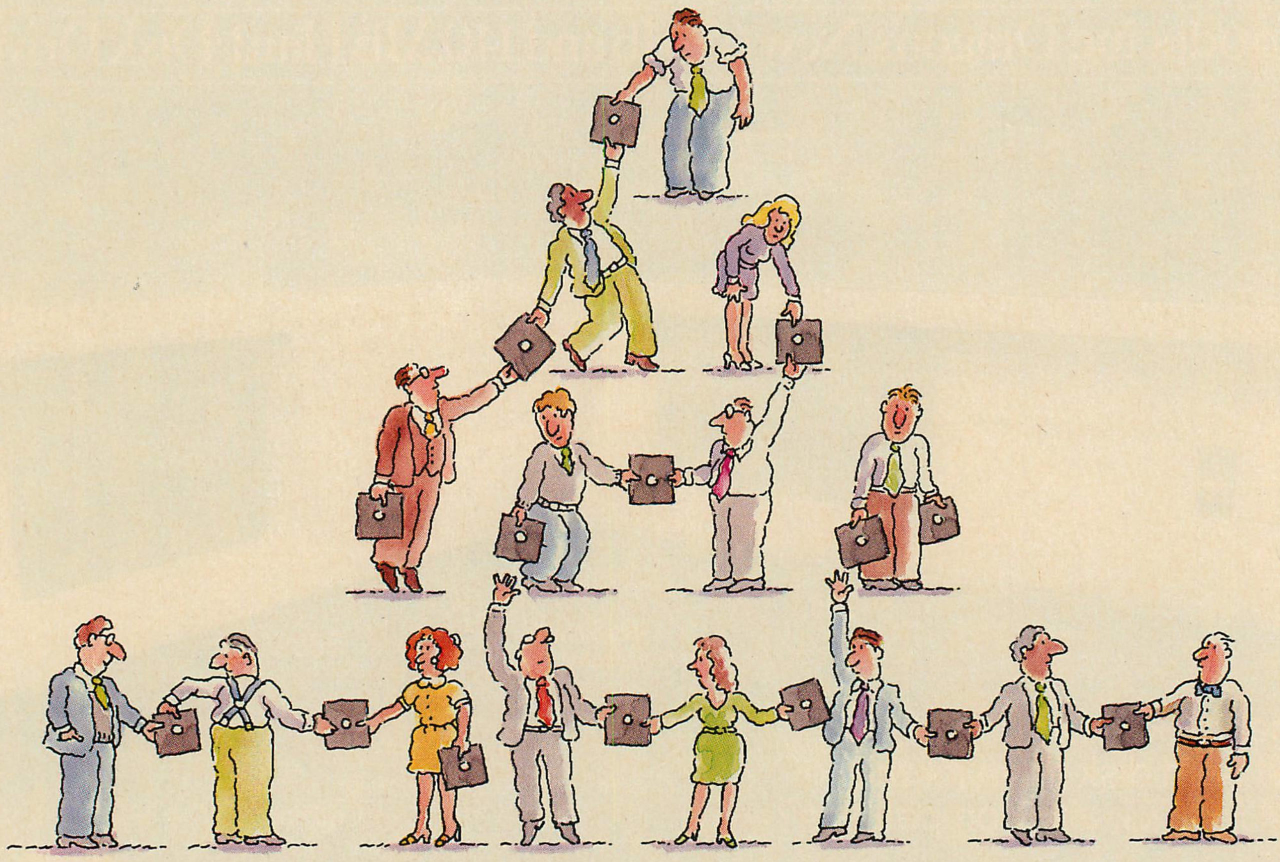
CIRCLE NO. 144 ON READER SERVICE CARD

THE END OF SOFTWARE FREEBIES.



Finally there's a foolproof way to protect software against unauthorized duplication. And the technology is all on the disk itself.

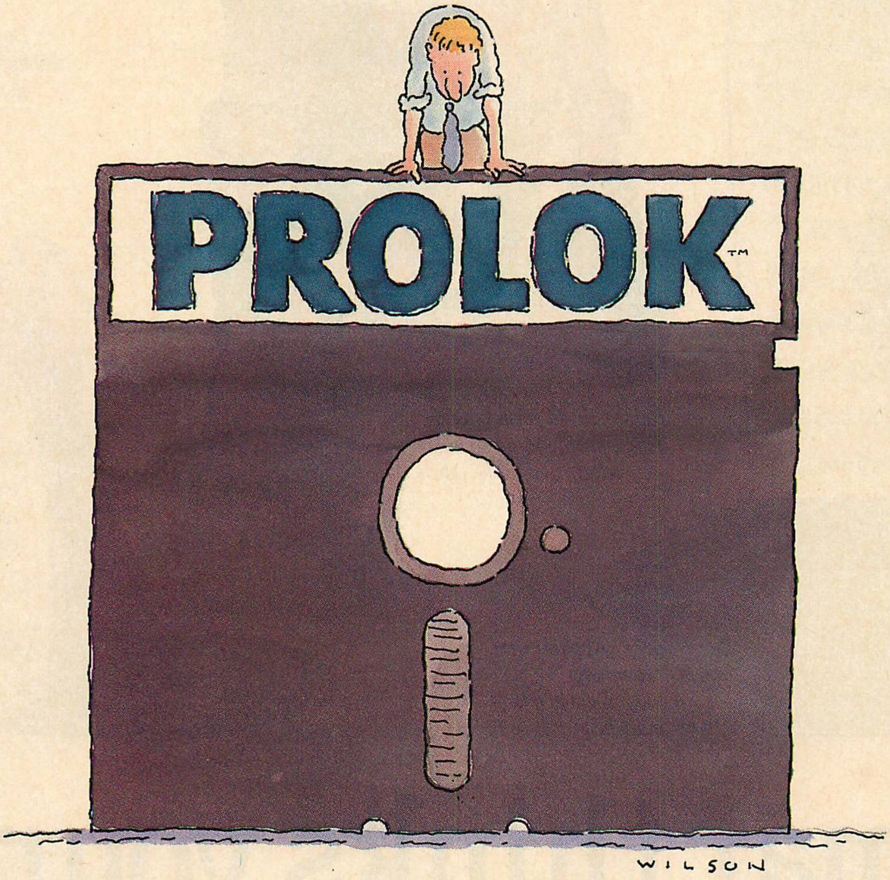
The new Prolok™ disk doesn't need add-on hardware. Instead each diskette is marked with a unique, physical "fingerprint." No two are alike. A precise description of the individual print is encoded magnetically. The fingerprint AND the description must match exactly before the software is decrypted and released to the system. No match, no access.

Its genius is its simplicity and familiarity. Prolok looks like an unprotected disk, loads like an unprotected disk, works like an unprotected disk. The user feels immediately at home and in command.

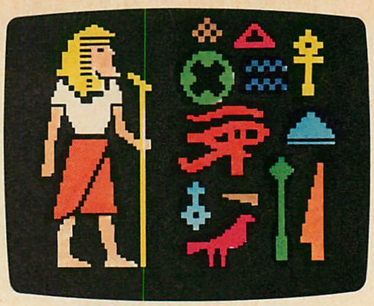
Backups are easily made via normal system utilities. However, to be read they must be accompanied in the system by the original Prolok disk.

Prolok puts the casual copier—and even the deliberate pirate—out of business. It barely

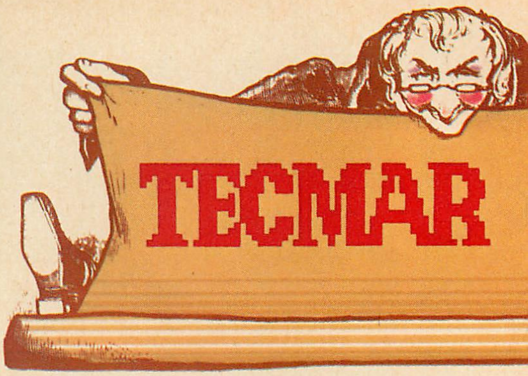
PROLOK. SOFTWARE


PROLOK
WILSON

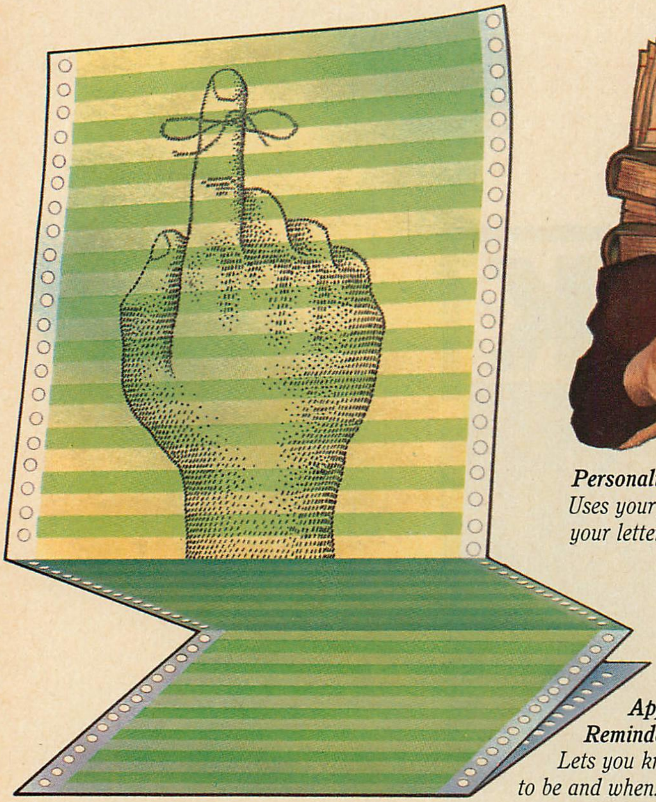
Clock/Calendar
Automatically inserts the date and time when you turn on your computer.



Encode/Decode
Ensures the security of your files.

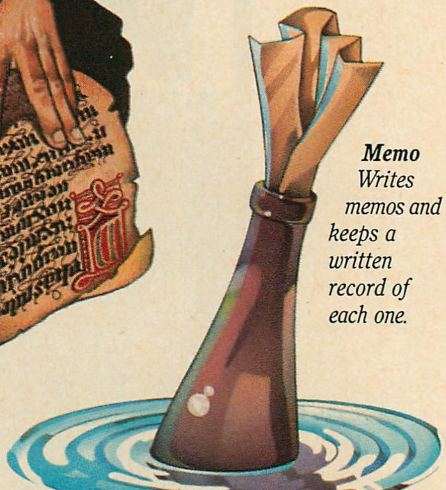


Calculator
Does your figuring in background mode so you won't have to change programs.



Appointment Reminder
Lets you know where to be and when.

Personalized form letters
Uses your file to personalize your letters and make labels.



Memo
Writes memos and keeps a written record of each one.

Tecmar thinks your PC

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Tecmar Multifunction Boards...
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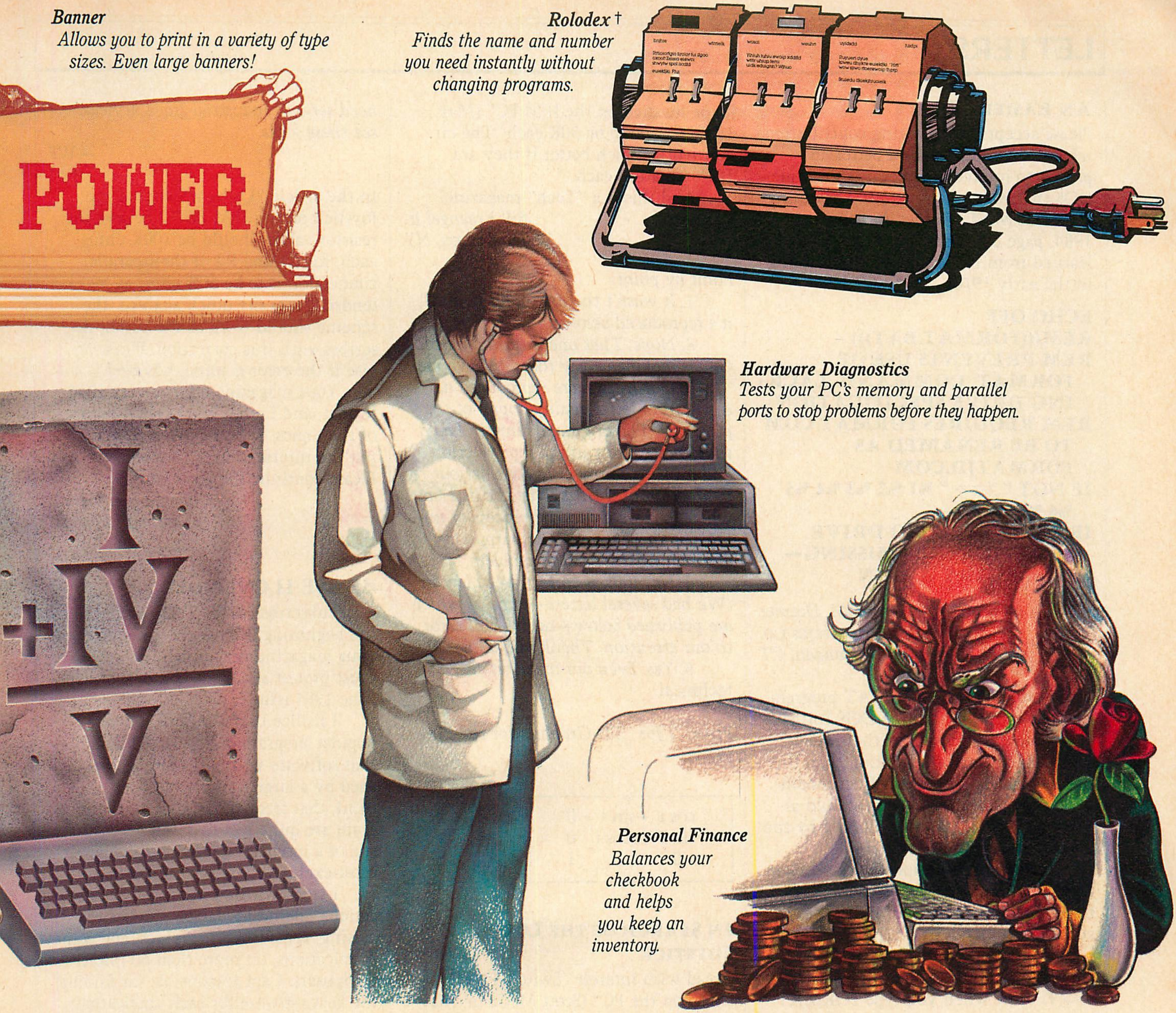
A Tecmar board will expand your computer's memory and increase its speed and efficiency. It will give you additional ports to accommodate a wide range of peripherals from modems and plotters to dot matrix and letter quality printers.

With a Tecmar board you can run powerful programs like Lotus 1-2-3™* and WordStar®†† on a PCjr. The RamSpooler makes printing a background task and frees your PC for other jobs. A built-in clock/calendar automatically inserts the date and time at power on and is independently powered by an easily replaced battery.

Every Tecmar multifunction board is run through a series of rigorous tests to ensure quality. Our incredibly low failure rate (0.4%) is unparalleled. All boards are additionally backed by a full one-year warranty.


Banner
Allows you to print in a variety of type sizes. Even large banners!
POWER
Rolodex †
Finds the name and number you need instantly without changing programs.
Hardware Diagnostics
Tests your PC's memory and parallel ports to stop problems before they happen.
I
+IV
V
Personal Finance
Balances your checkbook and helps you keep an inventory.

AN EASIER WAY

Please accept the following contribution, which we believe to be a better approach to intercepting commands under DOS than was explained in "Disarming DOS FORMAT" (James A. Folts, July 1984, page 32). This is a trick we learned from National CBS timesharing in the early 1970s.

```
ECHO OFF
REM(((FORMAT.BAT)))
REM PREVENTS USE OF
   FORMAT COMMAND LACK-
   ING DRIVE SPECIFICATION
REM REQUIRES FORMAT.COM
   TO BE RENAMED AS
   FORMATJD.COM
IF NOT " "==" %1 %2 %3 %4 %5
   %6 %7 %8 %9
IF " "=="%1" ECHO DRIVE
   SPECIFICATION MISSING—
   PLEASE TRY AGAIN
```

James M. Detmer
Detmer Systems Co.
New Canaan, CT

The problem of the FORMAT program mentioned in "Disarming DOS Format" is troublesome. However, there is a more straightforward solution than the one the article proposes. Direct modification of operating software should always be avoided. Those who live by the patch will surely die by it.

Here is my solution to the problem. First, rename FORMAT.COM to something you would not ordinarily use, such as FMT###.COM. Now create a batch file named FORMAT.BAT. It should contain only one line: FMT### A: /V. Now when you type FORMAT you will format a floppy on drive A:, but on an XT that is about all you use the FORMAT command for anyway.

Daniel T. Sullivan
Bolton, MA

TECHNICAL KNOCKOUT

I looked and looked, but I couldn't find where you hid figure 1 in "3-D Graphics for the IBM PC" (Jay Mallin, May 1984, page 36). When you find it, please send me a copy.

Does Susan Glinert-Gole (sic) really spell her name the way it appears in "Name, Rank, and Serial Number" (May 1984, page 192)?

Does Cole/Gole really want line 430 of ROMREAD.BAS in this same article to read . . ."-". . . ? The program runs much better if it's . . ."~". . . .

Does Scott McCann really want R1 and R2 in figure 1 of "Using a Switch-Type Joystick on the IBM PC" (May 1984, p. 195) to be 50K each? The circuit works much better if they are 100k (small k) each.

And this is a "Tech" magazine?

Bill Kraengel Jr.
Valley Stream, NY

Point by point:

1. It wasn't there. I found it, and it's reproduced below.

2. Nope. That one surprised us, too. G-C is making us pay for it, believe me.

3. Our listings are reproduced directly from letter-quality copies of the programs. The original definitely had a tilde that got lost in the reproduction and printing shuffle. We consider our reproduction of listings to be the best anywhere, but we are in the process of improving them for the sole purpose of eliminating this kind of problem.

4. No. 100k is correct. We blew it. (We had several letters—some of which are published below—calling this error to our attention. Thank you all.)

5. Yes. Even our mistakes are technical.

—WF

Figure 1 for "3-D Graphics for the IBM PC":

$$\begin{bmatrix} \cos i & -\sin i & 0 \\ \sin i & -\cos i & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

IN SEARCH OF THE LOST JOYSTICK

I read with interest "Switch-Type Joysticks on the PC" (Scott McCann, May 1984, page 195). I have one comment and one question. First, the resistive values shown in the schematic and mentioned in the text should be 100K ohm resistors. Second, I wrote to Fair Radio to obtain the joystick named in the article and received a catalogue that made no mention of this joystick. Does anybody know where I can buy a "professional" joystick with SPDT switches?

William M. McDonald
Salem, VA

We did a little checking, and, sure enough, we can't find the joystick in question. However, professional-quality joysticks and other input devices are available from Measurement Systems, Inc., 121 Water Street, Norwalk, CT 06854, 203-838-5561. Measurement Systems was kind enough to send us one of the joysticks (model 570), and it is very fine indeed. It also costs $200. If you need serious, industrial-grade devices, see these folks.

—WF

In the article "Using a Switch-Type Joystick on the IBM PC," I believe the resistor values should be 100K ohms each, for R1 and R2, if their parallel connection is to be 50K ohms as intended. From my quick analysis, the scheme should work as the author describes with this correction. Please advise if the error is mine, however.

Your magazine offers a very good format, and I enjoy the explicit nature of the topics, which allow a reader to put the information to immediate use. Please continue the good work.

David J. Anderson
Council Bluffs, IA

dBASE II OVERKILL

As a subscriber to *PC Tech Journal* from the beginning, I have generally enjoyed your magazine very much. However, I must protest about the contents of your June 1984 issue.

I realize that dBASE II is a very popular program on the IBM PC and that software written in dBASE II is used by a large number of people. I think that frequent articles on the program are quite justified. But an entire issue of a monthly magazine devoted almost exclusively to one product!

I work with a wide variety of applications, including database, word processing, spreadsheet, graphics, and communications, on more than 60 microcomputers. I am responsible for finding the best software for each application and helping people use the software effectively. I am interested in new techniques and products in all areas of microcomputing. The people I work with do not have time or inclination to explore these areas themselves.

I look to publications like *PC Tech Journal* for help in discovering new hardware and software products, along with technical pointers that may help me in my work. It so happens that we do not use dBASE II, but even if we did, I would prefer articles on a variety of subjects. For me, the investment of time and money in your June issue had a 0-percent return.

Alan Dolgoff
Microcomputer Manager
Hambrecht & Quist
San Francisco, CA

Pascal Times More

I read your review of the various Pascal compilers with great interest ("Pascal Times Four," Jeff Duntemann and-Michael Bentley, July 1984, page 58). The parts dealing with Turbo Pascal were very fair, at least as amended with the material on version 2.0. I would like to add a few comments.

Not only does the compiler take you back to the editor upon detecting a compilation error—the same thing happens on run-time errors as well. This is possible even when you have compiled to a disk file instead of to memory. If you've ever spent a day tracking down UCSD Pascal's cryptic "floating-point error" and "value range error" messages, you will appreciate the luxury of being directed immediately to the statement that is at fault.

Turbo's habit of clearing the screen at the start of execution seems to be Borland's sole error of judgment. You can defeat it with the aid of the debugger, however. In all programs I have examined, there's an INT 10 (hex) located at 02FC in the code segment: change this to a pair of NOPs and the screen will not clear. Since I don't use Turbo on a PC clone, I don't know how many other INT 10s would have to be disabled to avoid crashing the system, but a little prowling around with the debugger should do the trick. Since these are .COM files, rather than .EXE ones, the debugger will not make any difficulties about writing the revised version back to the file.

Turbo programs wipe out the transient part of DOS, so after any program is run, COMMAND.COM must be reloaded. As a result, the keyboard buffer is cleared, and programs cannot be rerun by means of F3.

Turbo programs are compact as well as fast. The runoff program that typed this letter occupies a .COM file that is 16K bytes long. The same runoff program written in Microsoft's FORTRAN-77 results in an .EXE file that is 37K bytes long.

Turbo's flash compiler gives you that same feeling of immediacy that is the sole redeeming feature of BASIC. The difference Turbo's quick turnaround makes in developing a complicated program has to be experienced to be believed. Of course, you're dealing with an infinitely better language than any BASIC known to me—but that should not need to be said.

Thomas W. Parsons
Brooklyn, NY

Your recent article on the various Pascals was very good. However, as an owner of Microsoft Pascal I would like to make a few points. I agree that the documentation is horrible, but there are three areas that seem to have been overlooked in the article. These are the metacommands (specifically $nofloatcalls/$floatcalls), the null object files (nulf.obj, nule6.obj, and nulr7.obj), and precision control.

First, the "floatcalls" metacommands specify how real math operations are done. The $floatcalls command is faster but requires more code. Second, the null object files replace potentially unused units in the code, such as the file system, error handling, or real operations, respectively. Third, the precision-control procedures (MPSRQQ, MPBRQQ, MPDRQQ) set the maximum precision for real numbers (23 to 64 bits). Below is a table of the TRIGTEST benchmarks with various options (using MS-Pascal 3.13).

trigtest ($floatcalls)	**size: 31068 0:07.0**
trigtest ($floatcalls,nule6)	**size: 30212 0:07.0**
trigtest ($floatcalls, mpsrqq)	**size: 31756 0:04.9**

As you can see, with the minimum real precision the benchmark required a significantly smaller amount of time.

Peter A. Mead
Greenwich, CT

Since I expect to buy a Pascal compiler soon, I was especially interested in reading "Pascal Times Four." I had already eliminated IBM's release 1.0 compiler from consideration, but I want to find out more about its release 2.0, mentioned in "Tech Releases" (July 1984, page 192). IBM's spec sheet sounds almost identical to the Microsoft release 3.2 covered by your review. Two questions come to mind:

What Microsoft release number does the IBM release 2.0 correspond to?

Did IBM use Microsoft's documentation or has it written its own? Is it any better than Microsoft's?

Thanks for a well-written article that helps to sort out the differences between these compilers.

Bill Tinsley
Iowa City, IA

There is no direct connection between IBM Pascal V2.0 and any Microsoft release of MS Pascal. However, we do know that MS Pascal V3.2 is a later (and more powerful) release of the compiler. Microsoft's manual set for V3.2 is a daunting document, but it is still miles ahead of either IBM V2.0 or any previous Microsoft document. I know of no good reason to buy IBM Pascal over MS Pascal—why place yet another layer of bureaucracy between yourself and the manufacturer of the product? It is still unclear to me what IBM could add to MS Pascal except confusion.

MS Pascal is nearly impenetrable to the Pascal newcomer. Although you may want it eventually to compile your magnum opus, I recommend picking up Turbo Pascal V2.0 to cut your teeth on. Now that it has full heap management, graphics, and overlays, Turbo V2.0 is shoulder-to-shoulder with the big guns.

—Jeff Duntemann

In Defense of Proloks

Mitchell Schoenbrum's letter concerning Prolok software security diskettes ("Proloks and Panaceas," June 1984, page 16) was somewhat bittersweet. Although he was highly complimentary, as was the author of "New Weapons for Fighting Software Piracy" (Werner L. Frank, February 1984, page 71), we are afraid Mr. Schoenbrum is laboring under a few misconceptions.

He addressed the level of security as his primary concern. We are realistic enough to agree that no software protection scheme is totally impenetrable. But then neither is the lock on your front door. The understood purpose is to keep the *majority* of offenders out. Prolok operates on this premise, and we have positioned it in the marketplace as an easily installed, low-cost, highly effective (probably 99 percent or better) means of software protection.

The friend Mr. Schoenbrum refers to undoubtedly was using one of our earlier versions. Our latest version offers six times the security level, plus we are constantly upgrading our product. Currently, there isn't a copy utility available that can penetrate our latest Prolok product, and it is impervious to standard debug equipment.

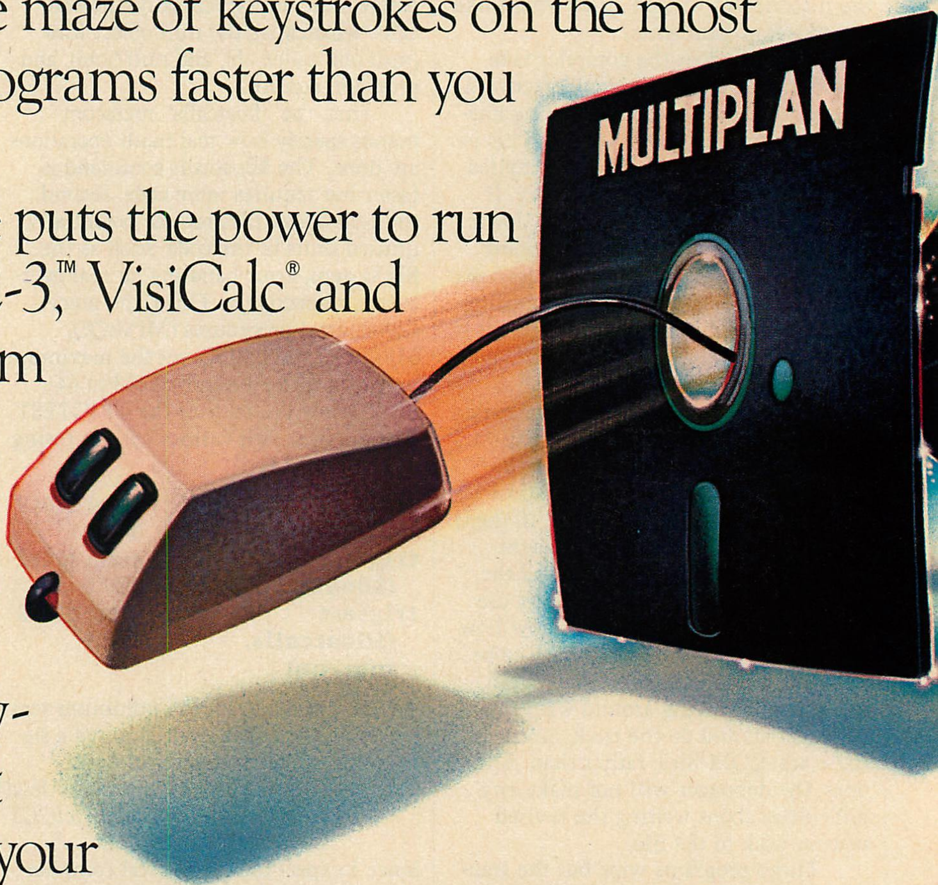
Again, we do not promise a panacea to software piracy. We simply offer the most effective, cost-efficient protection against the majority of offenders.

Michael H. Darling
Vice president, sales and marketing
Vault Corporation
Westlake Village, CA

Get yourself a

This little critter comes with specially-designed software that flies through the maze of keystrokes on the most popular business programs faster than you can say "cheese."

Microsoft® Mouse puts the power to run Multiplan,® Lotus 1-2-3,™ VisiCalc® and WordStar® in the palm of your hand. Click the left button on the mouse, a custom menu appears. In English, not hieroglyphics. Click the right button and execute your command: move text or data, edit, format, print. All at blinding speed without touching the keyboard.



It also lets you create your own menus for editing and formatting existing application programs. So people can learn programs quicker and do more productive work as they learn.

The mightiest mouse.

Microsoft Mouse runs circles around other mice. It is the high performance mouse for the IBM® PC and PC XT. From the company known for high

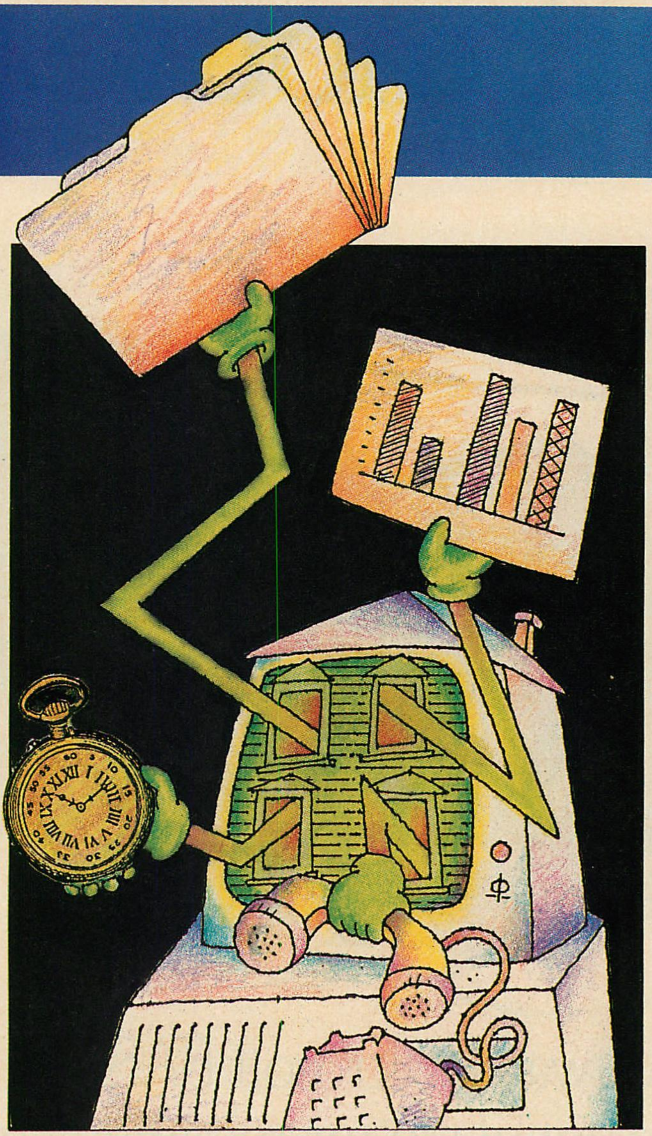
trained mouse.

performance software. Microsoft BASIC is the language spoken by nine out of ten microcomputers worldwide.

MICROSOFT®
The High Performance Software

Our MS™-DOS operating system tells your IBM PC how to think.

So don't monkey around with any other mouse. Call 800-426-9400 (in Washington State call 206-828-8088) for the name of your nearest Microsoft dealer. Then go with Microsoft Mouse. The mouse that soars.



RANDOM RUMORS AND GOSSIP

Microsoft President Bill Gates recently expressed the view that **IBM** has "a year or two to go" as the prevailing microcomputer standard before 80286 technology takes over. IBM is expected to announce its 80286-based system either this month or next with initial deliveries expected at year's end. This should be an expansion of the PC family and not a replacement for any of the family members. **IBM** is also rumored to be developing a speedy—300 lines per minute—new printer for the PC. **Compaq** introduced in July a desktop hard disk system using the 8086 microprocessor and dual-speed clocking (IBM standard—4.77Mhz and a higher speed—8Mhz). At least two other companies are already showing such products. The machine comes equipped with a built-in tape back-up system for the hard disk. IBM provides no such tape back-up for the XT; about 27 disks are needed to back-up the hard disk. **Sharp Electronics** is reportedly already showing to several computer manufacturers an electroluminescent display panel of 80 characters by 25 lines; the display has a thickness of only 1.5 inches. **Hewlett-Packard** is the first company to introduce a product that uses it. **IBM** is developing a 3.5-inch hard disk drive that stores 20 Mbytes; the company is expected to use these new "micro-Winchesters" in systems that will be introduced next year and to offer them to other computer makers. **Eagle Computer**, a maker of IBM-PC compatibles, is reported to be having problems with cash flow and poor sales and the company is considering some layoffs. IBM's most recent price reductions may exacerbate Eagle's problems. **Digital Research** is expected soon to release Crystal, a software developer toolkit containing a large collection of routines that can be merged and integrated into programs to reduce development time and to provide features such as menus, graphics, and multitasking. Several vertical and scientific application software packages are soon to be announced by **IBM**. Expect a big emphasis on educational software. **IBM** dealers reportedly have been applying increasing pressure on the company to allow them to sell the 3270-PC, which currently is available only via IBM's own sales force. Reports now are circulating that IBM is seriously considering this for selected business-oriented dealers. **IBM** is expected to double the number of retail outlets (4,000 by 1985) for its personal computer products within the coming year. Most of this new increase is expected to come from office equipment dealers. With PC*jr* sales not measuring up to expectations, rumors are rampant that **IBM** is seriously considering distribution of the *jr* through mass market outlets. Even with the new base price of $999, however, the machine may be too expensive for this channel. Finally, rumors of an IBM lap-size portable keep popping up. The latest comes from Europe, where IBM is said to be testing an 8088-based machine made by **Matsushita Electric Co., Ltd.** with bubble memory, ROM software, a display with 8 lines by 80 characters, and a disk drive.

MULTIPROCESSING ON THE PC

IBM is reportedly beta testing a multitasking version of MS-DOS for its forthcoming 80286-based system. However, it should be noted that Digital Research, Inc. (DRI) has been delivering a multiprocessing DOS with PC-DOS compatibility since July. That product, Concurrent PC-DOS, will run up to 256 PC-DOS or CP/M tasks concurrently on a standard PC; four of these tasks can be viewed on the display. Concurrent PC-DOS also has a true windowing system and communications support.

DRI has also introduced a plug-in board for the PC that turns Concurrent PC-DOS into a multi-user system that will support up to four users. The board and associated software are called StarLink. It thus appears that DRI has about a six- to nine-month lead over IBM's introduction of a multi-user PC system, although that lead may suffer from Concurrent PC-DOS's lack of full PC-DOS 2.0 compatibility.

ILLUSTRATION • DAVID POVILAITIS

THE TECH JOURNAL NEWSLINE

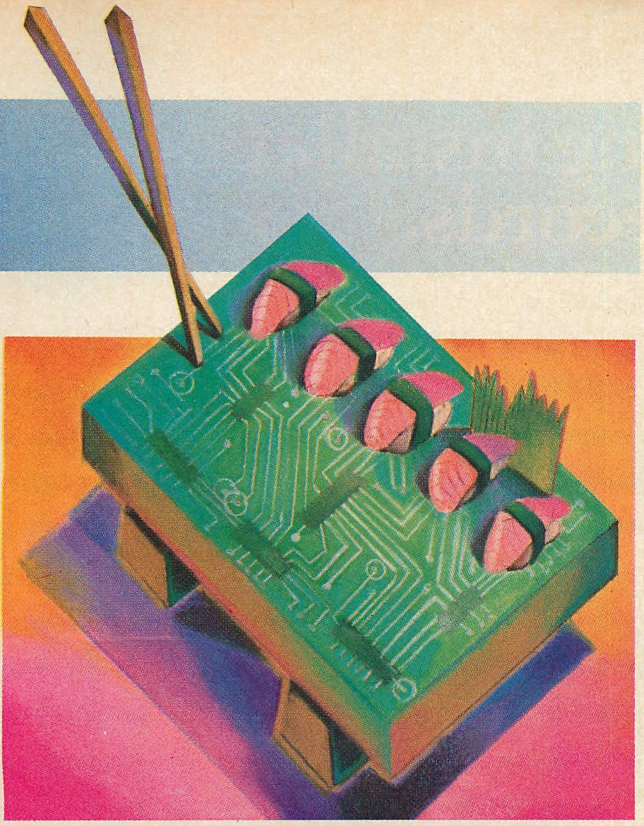


ILLUSTRATION • KEVIN McPHEE

News, views, and gossip on the IBM and IBM-like marketplace

IBM NETWORKING

IBM will probably introduce an interim LAN system from an outside vendor to tide it over until it can introduce its own LAN in 1986 or 1987. The company is known to be evaluating LAN systems from Sytek, 3Com, and Ungermann-Bass for possible adoption. IBM has named six of the seven Bell operating companies as distributors and installers of its LAN cabling system.

IBM is known to be working with Texas Instruments (TI) on the development of ICs for its LAN project. TI is believed to have run into development problems, which could be causing IBM to reassess its fundamental LAN architecture. Development of a networking system to interconnect a large number of varied devices that will work reliably and easily is a mammoth task, and IBM appears to be taking the time to do it properly. Further, the demand for LAN systems appears to be developing slowly; IBM really may not be under a great deal of pressure to get its system out. The company is already known to have wired 10 of its buildings in Rye Brook, New York, with 3.5 million feet of cable connecting 2,800 devices, and it is wiring 11 additional buildings. Thus, IBM is expected to do intensive testing of its LAN system before it is released. This will take time.

CUSTOMS SEIZES PC COPIES

The U.S. Customs service in Seattle recently seized a large number of allegedly counterfeit copies of the IBM PC, after IBM registered its copyright with customs and pointed out the copies. IBM thus is following in Apple's footsteps in attempting to protect its copyrights.

A number of Far Eastern suppliers have been shipping copies of the Apple II into the United States without the copyrighted ROMs, and Apple has requested that U.S. Customs take action against these companies. Apple has also encountered a similar problem in Canada, where the government has been less aggressive in stopping illegal importing of Apple copies. A large number of these copies make their way into the U.S. from Canada. The likelihood is that the same will happen with IBM PC copies.

IBM may be in for more problems as a software house in Norwood, Massachusetts, called Phoenix Software Associates has announced the availability of a BIOS ROM that is functionally identical to the copyrighted IBM BIOS ROM and yet does not infringe on the IBM copyright. A license for the Phoenix ROM and Phoenix version of PC-DOS 2.1 is only $290,000. Several Far East vendors have already taken out licenses, and PC-compatibles are expected to be introduced shortly from more than a dozen Taiwanese and Japanese manufacturers.

At the same time, IBM has added a ROM BIOS upgrade to its price list. Although the chip contains the entire BIOS and thus would seem fair game for the manufacturers of clones, IBM is protecting itself by requiring that purchasers exchange their old ROM for the new one. The new ROM, besides incorporating a number of fixes for known bugs, also includes the ROM scan feature that is needed to operate the IBM Cluster or to allow a boot from a hard disk.

IBM PRODUCT CENTERS — GAIN OR LOSS?

IBM recently denied rumors that its chain of 80 Product Centers was operating at a loss and that it does not plan to open any more centers. Industry pundits expect IBM to continue opening Product Centers and possibly to have as many as 100 in operation by the end of the year.

Rumors have been circulating in the industry that IBM's Product Centers were having problems with high labor costs, high overhead, and low sales volume as a result of high prices and limited product selection. Future Computing recently reported that the Product Centers account for about 5 percent of IBM's PC sales, whereas independent stores and chains account for 51 percent of sales. The remaining sales are via VARs, VADs, and IBM's sales force. Previous estimates had IBM selling as much as 65 percent through its direct channels.

RANDOM NEWS BITS

Intel has given **Oki Electronic Industry** of Tokyo a license to make a CMOS version of the 8088 microprocessor used in the IBM PC. Harris is already making a CMOS version of the 8086, which is used in the HP-110 portable, and also will soon be making an 8088 CMOS chip. **Dataquest**, a market research outfit, reports that notebook-size computers made up 3 percent of systems sold last year, and it predicts sales of such computers this year will increase to 7 percent and by 1988 will rise to 30 percent. **Sony** has introduced a color monitor, using its Trinitron CRT, that it claims will display 1,280 by 1,024 pixels.

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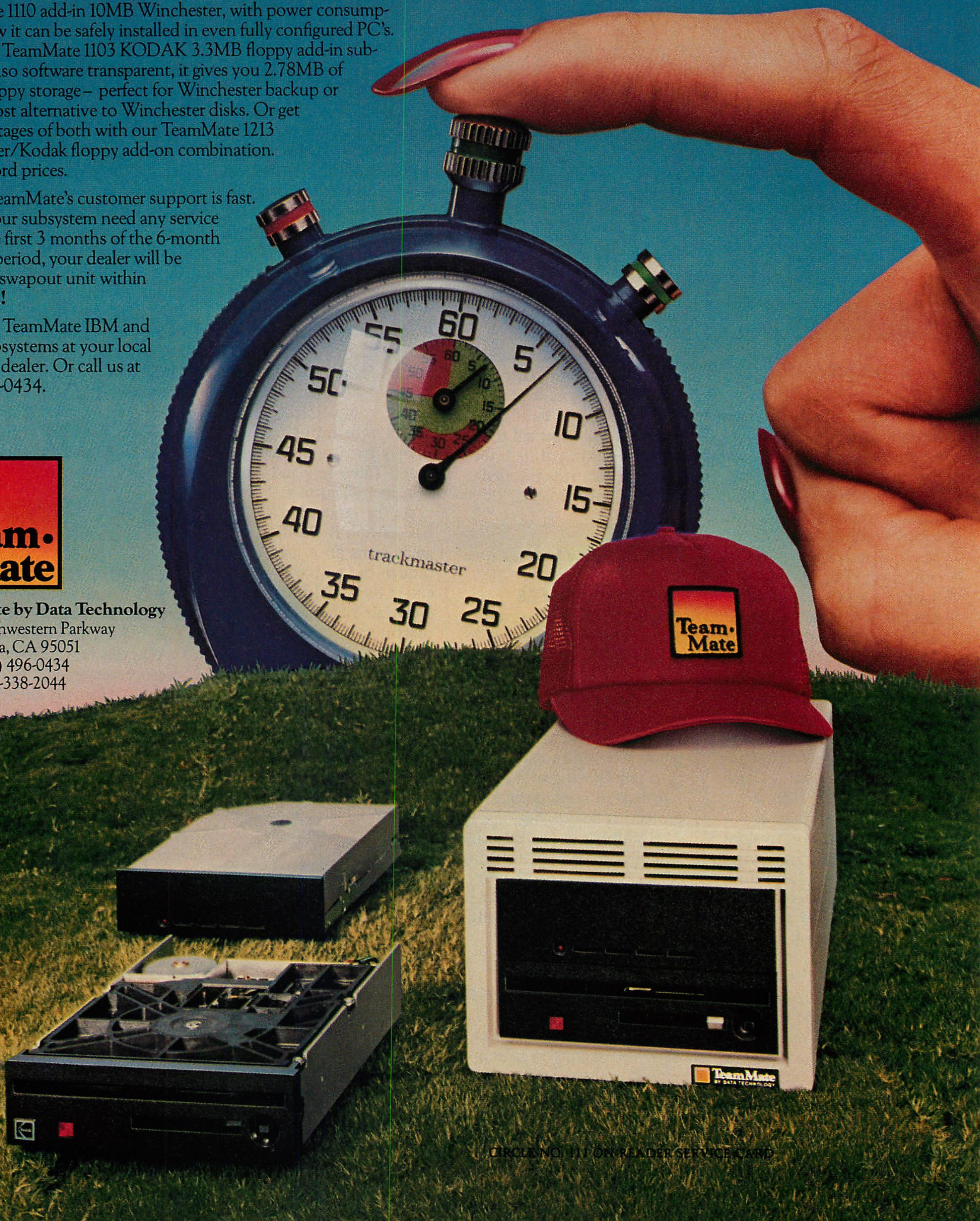

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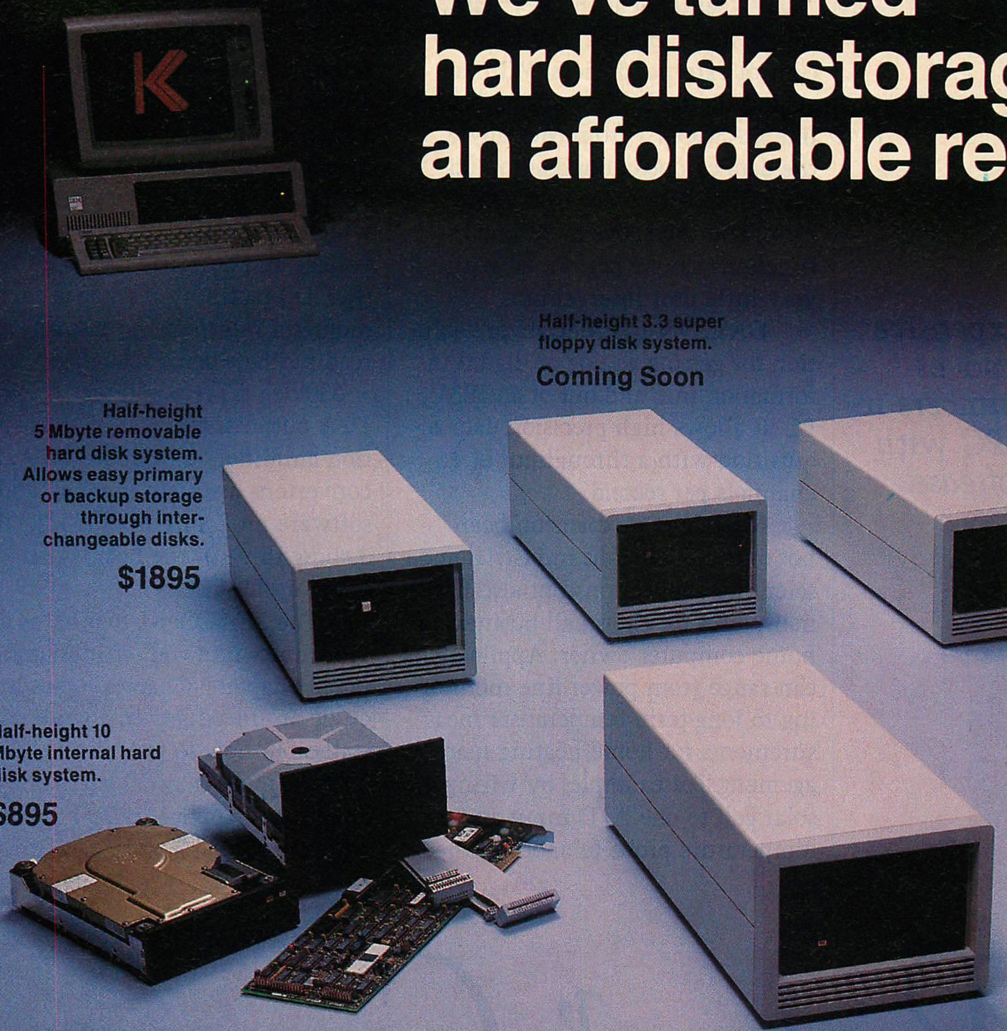

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Poor Richard's Converter

FROM A TO D

Metrabyte's inexpensive DASCON-1 moves analog/digital numbers in and out of the PC with the greatest of ease.

WILLIAM H. MURRAY

One of the best features of a small system is its ability to analyze user data. The data, entered at the keyboard, can be listed, plotted, and used to control external devices. With an analog/digital I/O expansion board like DASCON-1 from Metrabyte, the data can be entered automatically in either analog or digital form, and the above-mentioned functions can be performed with very little user intervention.

DASCON-1 is Metrabyte's solution for getting analog or digital information into and out of an IBM PC. It allows high-precision data acquisition with a throughput of 16 channels per second.

Metrabyte's expansion board not only has obvious industrial and scientific applications but also has many uses for the small-business or home computer owner. Applications can range from power-line monitoring to long-term temperature measurements for home heating management. For example, by wiring a solar cell to one A/D input and a temperature probe to another, the user could investigate the effect of incident sunlight on greenhouse temperatures. Using the software provided with DASCON-1, this data can be saved and plotted at a later date, or it can be plotted as it is received by the various inputs.

The DASCON-1 package contains a four-channel, dual-slope A/D converter (12 bits plus a sign bit) boasting a resolution of .0005 volts while configured in the differential mode; a clock/calendar, with battery back-up, which provides timing references at 1 second, 1 minute, or 1 hour for data acquisition and which can be accessed to update the date and time of the PC; 12 bits of digital I/O (through two ports), which are TTL-compatible; internal voltage and current references; two (R.T.D.) platinum resistance thermometer interfaces for temperature readings between −200 deg. C and +650 deg. C; two optional 12-bit D/A outputs; optional instrumentation amplifiers for two of the A/D converters; a system manual; and software programs. Photos 1, 2, and 3 show three of the boards that make up DASCON-1.

The DASCON-1 manual is divided into nine well-written and detailed chapters. Chapter topics include an introduction, a guide to installation, how to program DASCON-1 (more than 20 pages of examples and applications), how to set and read the on-board clock, how to use the graphics package, linearization of data, special applications, accessories (to make life easier), and a description of the calibration program and test information. Three appendices describe the various connections to DASCON-1; input and output data ranges, accuracy, and precision; and user-serviceable parts.

Refer to table 1 for details on DASCON-1's electrical and conversion specifications.

William H. Murray teaches computer science at Broome Community College in Binghamton, NY. He is a contributing editor.

ILLUSTRATION • JOE CIARDIELLO

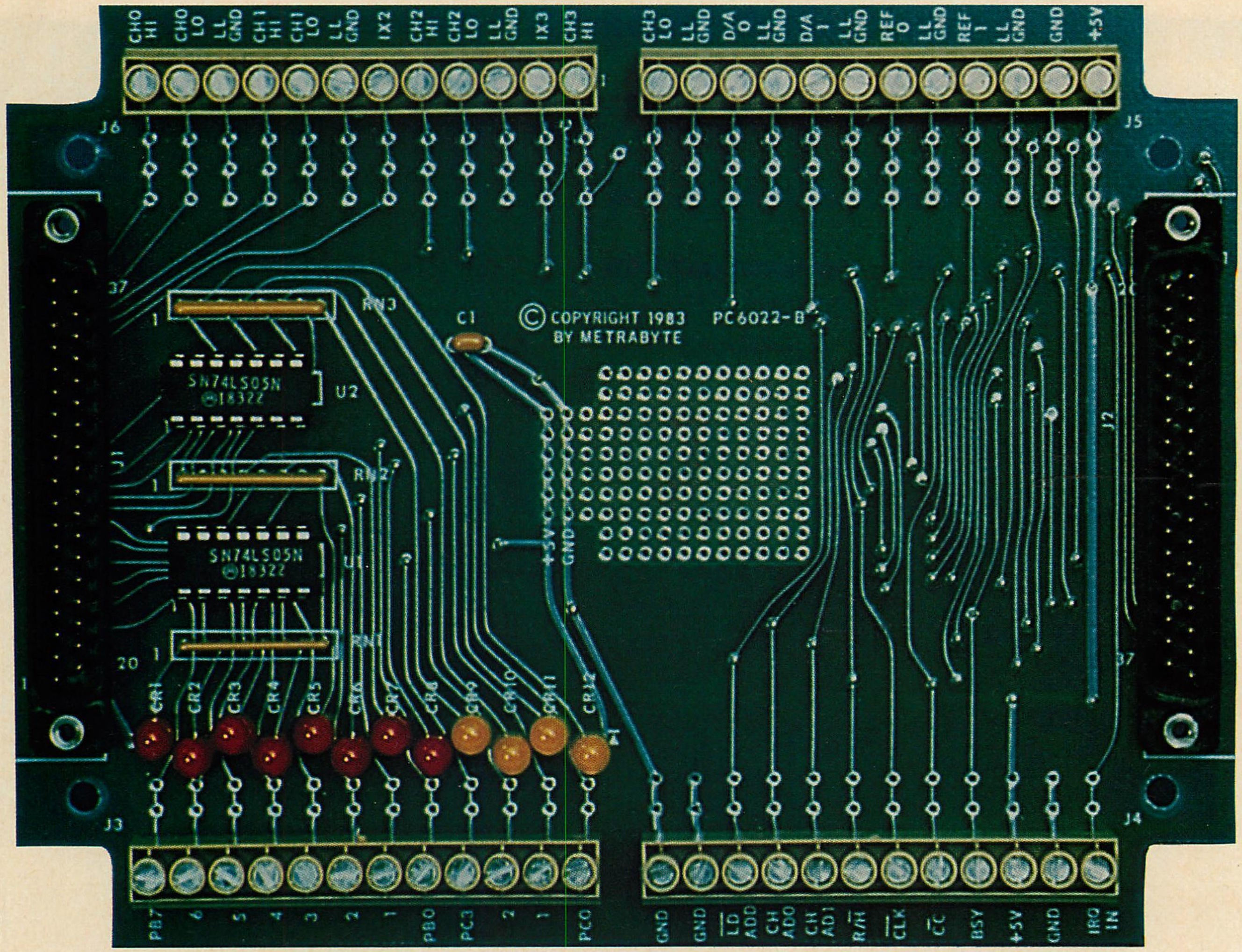

***Photo 1:** A screw terminal board that makes all analog and digital inputs and outputs available via miniature screw terminals. All 12 digital I/O lines are monitored by LEDs.*

EXPERIMENTING WITH DASCON-1

One of the easiest techniques for receiving from or sending data to DASCON-1 is to use the software included with the board. Eleven different modes allow the user great flexibility in programming in the BASIC language. Table 2 gives a short description of each mode. The various modes are accessed from BASIC with a CALL statement and parameters that are to be passed:

CALL DASCON1 (MODE, CHANNEL, DATA 0, DATA 1, BASE ADDRESS)

As an example of how to access data from channels 0 and 1 on the A/D converter, consider the program in listing 1. Mode 0 is a free scan mode that samples all four A/D channels. Lines 30-80 set aside part of the memory that is reserved for BASIC in order to BLOAD DASCON1.BIN. Actually, this program can reside outside of the BASIC segment. Lines 90-150 initialize DASCON-1 for mode 0 operation. This only needs to be done once per program, unless modes are changed. Line 160 is the actual CALL statement to DASCON-1. Data for channels 0 and 1 is returned to DIO (0)% and DIO(1)% in terms of bits. In other words, +/−4095 bits correspond to +/−2.0475 volts. Lines 170-180 convert the bit readings to voltages, and line 190 prints the data to the screen.

Listing 2 is a modification of the original program and will permit the user to receive data upon an interrupt from the clock. In this program, mode 3 is originally called to start the interrupt process. Once

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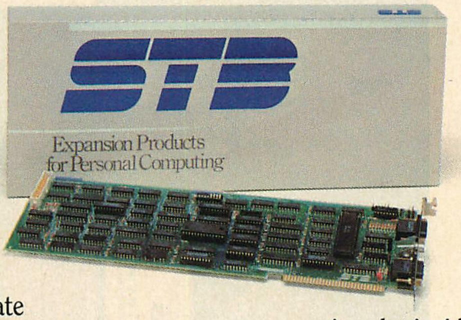

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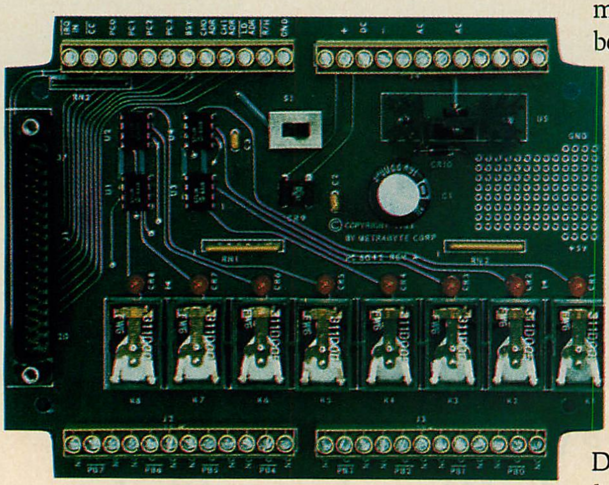
Photo 2: *An electromechanical relay board that contains 8 relays rated at 120 volts RMS at 3 amps resistive load, for controlling power loads.*



called, the system will continue to generate interrupts until reset (a call to mode 4). A call to mode 6 (lines 170-200) reports the readings from each interrupt. This program was written to sample data on channel 0 once a second (the interrupt jumper was set to one second) and print data continuously to the screen.

Listing 3 is an extension of listing 2 that permits saving data in a file on the B: drive called PDATA. The manual is very detailed on how file access can be made. The first data entry (line 170) defines how many data points are to be recorded (the number of data points = 31 − 1 for this example). Line 180 specifies a plotting format that will be described later.

To test DASCON-1's temperature probe, I monitored the temperature of a cup of coffee for 30 minutes. Data were recorded at 1-minute intervals, saved on a disk, and plotted using the graphics software included with DASCON-1. The temperature readings that were being reported using DASCON-1 were found to track accurately when checked against a mercury laboratory thermometer. The program shown in listing 3 recorded the actual data into the PDATA file. Figure 1 shows a plot of the data.

Several nice features about DASCON-1's graphics software package deserve special mention: up to 15 different data files can be plotted on the same graph; data entered from the keyboard can be plotted; by using a special program the X or Y axis can be set to any size; data can be plotted as they are received; and data points can be plotted by themselves or a line can be drawn between successive points.

For another test of DASCON-1's capabilities, I used Titchener Hall, one of the buildings at the community college where I teach, which won the award for having the most poorly designed air-conditioning system in the state of New York. Part of the problem is that on sunny

Photo 3: *A solid-state I/O board that uses up to 8 modules of the OPTO-22 type. The modules are selected to meet the user's specific I/O requirements.*

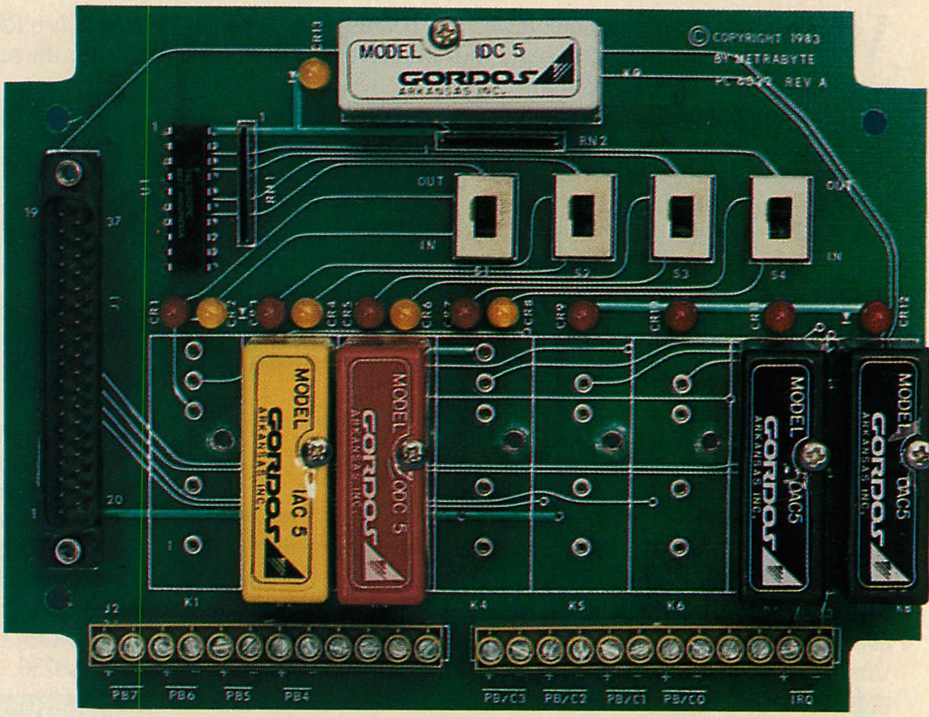


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Table 1: *DASCON-1 Specifications*

Power Consumption	
+5 volt supply	450mA typical/600mA maximum
−5 volt supply	8mA typical/ 15mA maximum
−12 volt supply	70mA typical/100mA maximum
−12 volt supply	60mA typical/100mA maximum
Analog Input	
Resolution	12 bits plus sign
Accuracy	.01% of reading +/− bit
Full Scale	+/−2.0475 volts
Polarity	automatic
Zero	automatic
Overvoltage	continuous single channel to 120 volts R.M.S.
Configuration	differential
Common Mode	+/− 2 volt minimum
Common Mode Reject	60 db min., 70 db typical
Input current	1nA max at 25 deg. C
Input filter	Switchable on each channel 30 db atten. at 60 Hz.
Temperature coefficient	Gain or full scale −25ppm/deg. C max
Type	Integrating dual slope
Conversion Rate	30 conversions/sec. min (4 channels)
Digital I/O	
Output (low volt)	0.45 volt max at Isink = −1.7mA (1 standard TTL load)
Output (high volt)	2.4 volts minimum at Isource = 200 uA
Darlington drive	4mA max, 1mA min with Rext =750 ohm
Input low voltage	0.8 volt max, −0.5 volt min
Input high voltage	2.0 volt min, 5 volt max
Input current	+/− 10 uA max
Voltage and Current Sources	
Voltage sources (2)	+/− 6.8 volt at 5 mA max
Clock	
Format	24 hour with leap year
Hold up time	2 months at 25 deg. C
Battery charge	24 hours max.
Stability	2 sec/month typical
Output pulses	1024 Hz, 1 second, 1 minute, 1 hour

One of the easiest techniques for receiving from or sending data to DASCON-1 is to use the software included with the board.

days the greenhouse effect is responsible for increasing the temperature on one side of the building and not the other.

One possible solution would be to monitor the amount of sunlight on one side of the building and use a zoned heating/cooling system to start the air conditioning on that side only. This would involve reading in an analog voltage from a solar cell, processing the information, and making a digital decision about whether or not to turn on the air conditioning system. DASCON-1 could be used to input the analog voltage to the PC and output the digital decision to a relay.

Listing 4 shows the modification to listing 1 that is required to produce this interface. The solar cell was wired to analog input channel 0 and read with the CALL in line 160. If the converted analog voltage is over 500 (in binary form) then line 170 will set up DIO%(0) for a digital output of 1 for ON or 0 for OFF. Digital outputs can be achieved by CALLing mode 9.

This program continuously

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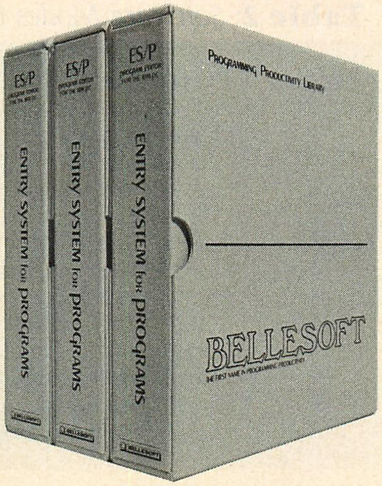

C

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4. **Program Editing.** ES/P manipulates program structures correctly with a single keystroke, allows you to delete or move statements easily.
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monitors the analog voltage and responds with the digital decision. It would be necessary to build in logic controls to prevent the system from cycling on and off as clouds passed over the solar cell.

In the Titchener Hall case, only one channel of digital output was monitored because I only needed to turn a relay on or off. Actually, DASCON-1 provides 8 bits of digital output at the PB output.

High-quality Addition

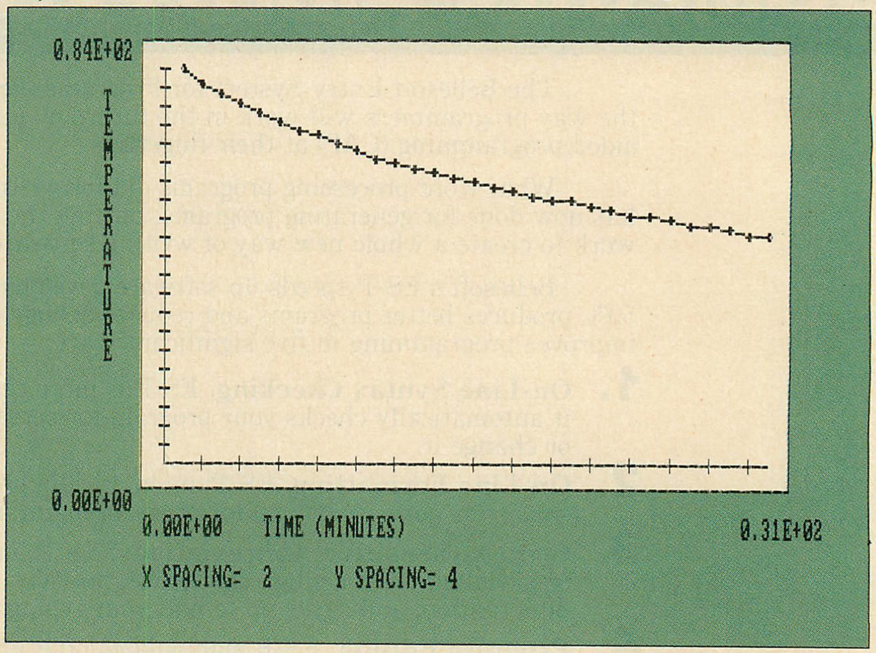
In DASCON-1, Metrabyte has produced a high-quality, professionally designed addition to the IBM PC that will make data input and output easy. The careful design is evident from the manual and software programs that come in the package. Details such as a rechargeable on-board clock battery, easy-to-reach calibration pots, and sufficient calibration software make DASCON-1 a pleasure to use.

DASCON-1
Metrabyte Corporation
254 Tosca Drive
Stoughton, MA 02072
617-344-1990
$485

Table 2: *Software Modes for BASIC Calls*

Mode	Function
0	A/D free scan, data collected asynchronously
1	Conversion requested on single A/D channel, data transferred when finished
2	Conversions requested on all channels, data transferred when finished
3	Same as mode 2 but conversions are performed by interrupt
4	Disables interrupt modes 3 and 5
5	Same as mode 0 but data is collected on interrupt
6	Collects data from interrupt modes 3 and 5
7	Outputs data to a single D/A channel
8	Outputs data to both D/A channels
9	Outputs/inputs data to/from digital I/O ports
10	Enables/disables clock pulse output

Figure 1: Plot of Data in test of DASCON-1 Temperature Probe



Listing 1 LISTING1.BAS: Routine To Access Data from Channels 0 and 1 on the A/D Converter

```
10 REM A/D 4 CHANNEL FREE SCAN (MODE 0)
20 REM PRINTING OUT CONTINUOUS DATA ON A/D CHANNEL 0 & 1
30 CLEAR,62463!
40 DEF SEG=0
50 SG=256*PEEK(&H511)+PEEK(&H510)
60 SG=62463!/16+SG
70 DEF SEG = SG
80 BLOAD "DASCON1.BIN",0
90 MD%= 0
100 CH%=0
110 DIM DIO%(32)
120 DIO%(0)=0:DIO%(1)=0
130 BASADR%=768
140 DEF SEG = SG
150 DASCON1 = 0
160 CALL DASCON1 (MD%,CH%,DIO%(0),DIO%(1),BASADR%)
170 ATOD0 = .0005*DIO%(0)
180 ATOD1 = .0005*DIO%(1)
210 PRINT ATOD0,ATOD1
220 GOTO 160
```

Listing 2 LISTING2.BAS: Modification of Original Program

```
10 REM A/D CHANNEL 0 MONITOR WITH INTERRUPT
20 CLEAR,62463!
30 DEF SEG=0
40 SG=256*PEEK(&H511)+PEEK(&H510)
50 SG=62463!/16+SG
60 DEF SEG = SG
70 BLOAD "DASCON1.BIN",0
80 OPEN "I",#1,"DASCON1.ADR":INPUT#1,BASADR%:CLOSE#1
90 DIM DIO%(8)
100 MD%=3
110 CH%=2
```

```
120 DIO%(0)=0:DIO%(1)=0
130 BASADR%=768
140 DEF SEG = SG
150 DASCON1 = 0
160 CALL DASCON1 (MD%,CH%,DIO%(0),DIO%(1),BASADR%)
170 MD%=6
180 CH%=0
190 CALL DASCON1 (MD%,CH%,DIO%(0),DIO%(1),BASADR%)
200 IF DIO%(8)=0 GOTO 170
210 PRINT I,DIO%(0)
220 GOTO 100
230 END
```

Listing 3 LISTING3.BAS: Extension of Listing 2

```
10 REM A/D RECORDING CHANNEL 0 ON INTERRUPT TO DISKETTE
20 REM SET TO RECORD 30 DATA POINTS, THEN QUIT
30 REM SET TO SAVE DATA ON INTERRUPT ONLY!!!!!!!!
40 CLEAR,62463!
50 DEF SEG=0
60 SG=256*PEEK(&H511)+PEEK(&H510)
70 SG=62463!/16+SG
80 DEF SEG = SG
90 BLOAD "DASCON1.BIN",0
100 DIM DIO%(8)
110 DIO%(0)=0:DIO%(1)=0
120 BASADR%=768
130 DEF SEG = SG
140 DASCON1 = 0
150 OPEN "B:PDATA" AS #1 LEN=30
160 FIELD #1,15 AS D$,15 AS N$
170 LSET D$=MKS$(31)
180 LSET N$=MKS$(1)
190 PUT #1
200 FOR I=1 TO 31
210 MD%=3
220 CH%=2
230 CALL DASCON1 (MD%,CH%,DIO%(0),DIO%(1),BASADR%)
240 MD%=6
250 CH%=0
260 CALL DASCON1 (MD%,CH%,DIO%(0),DIO%(1),BASADR%)
270 IF DIO%(8)=0 GOTO 260
280 TEMP%=.2*(DIO%(2))
290 LSET D$=MKS$(I)
300 LSET N$=MKS$(TEMP%)
310 PUT #1
320 PRINT I,TEMP%
330 NEXT I
340 CLOSE#1
350 END
```

Listing 4 LISTING4.BAS: Modification of Listing 1

```
10 REM A/D 4 CHANNEL FREE SCAN (MODE 0)
20 REM PRINTING OUT CONTINUOUS DATA ON A/D CHANNEL 0 & 1
30 CLEAR,62463!
40 DEF SEG=0
50 SG=256*PEEK(&H511)+PEEK(&H510)
60 SG=62463!/16+SG
70 DEF SEG = SG
80 BLOAD "DASCON1.BIN",0
90 DIM DIO%(8)
100 MD%= 0
110 CH%=0
120 DIO%(0)=0:DIO%(1)=0
130 BASADR%=768
140 DEF SEG = SG
150 DASCON1 = 0
160 CALL DASCON1 (MD%,CH%,DIO%(0),DIO%(1),BASADR%)
170 IF DIO%(0)>=500 THEN DIO%(0)=1 ELSE DIO%(0)=0
180 MD%=9
190 CH%=0
200 CALL DASCON1 (MD%,CH%,DIO%(0),DIO%(1),BASADR%)
210 GOTO 100
```

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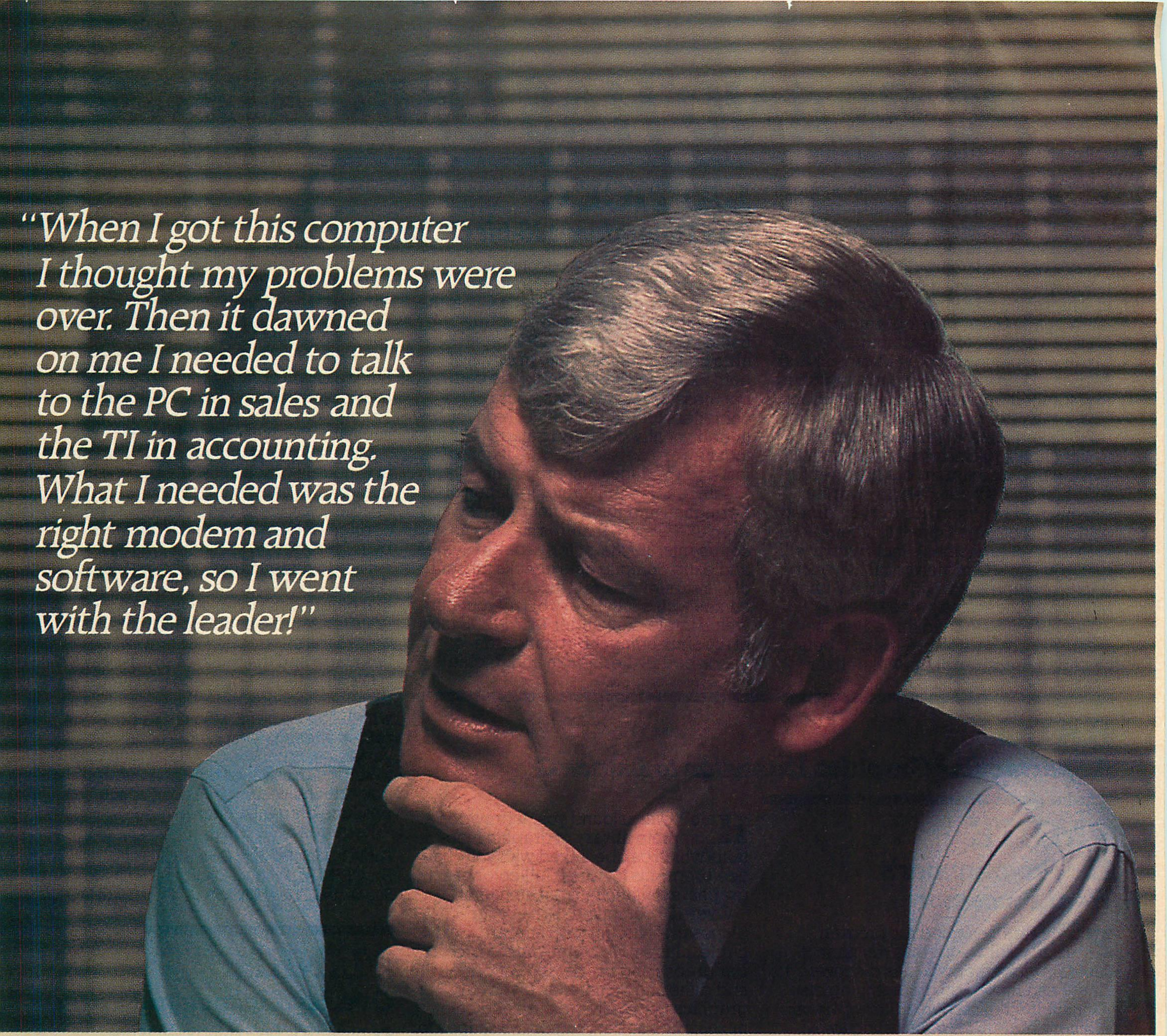

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Plink86 is a two pass linkage editor. On the first reading it determines all modules which need loading, to insure greater flexibility in assigning memory segment addresses before the disk file is created on the second pass. It can even sub-divide its linked output into multiple files for programs which must span more than one disk.

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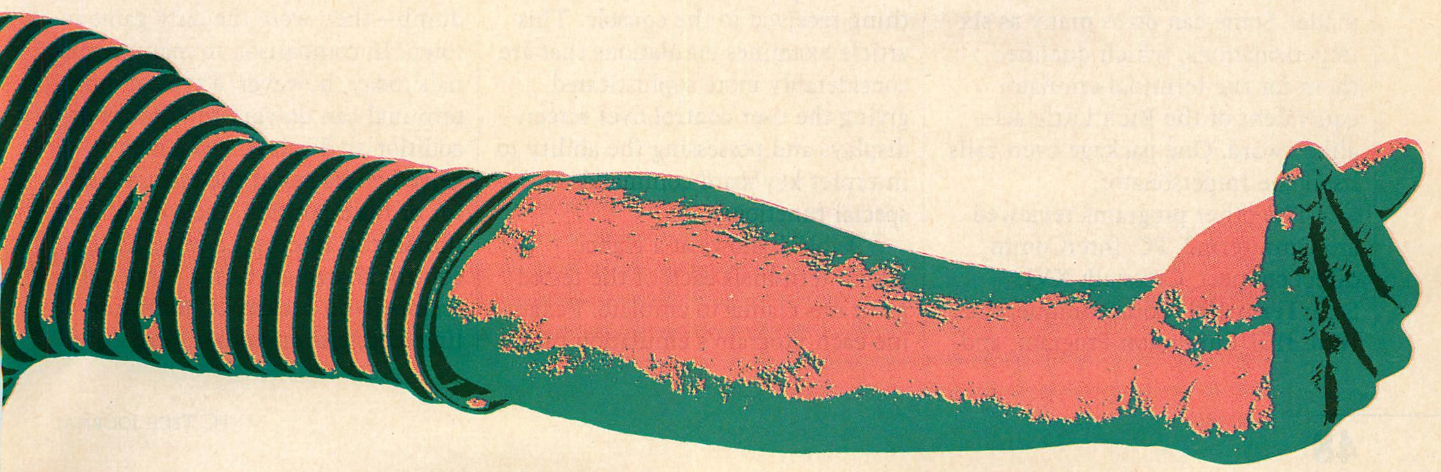
HIGH-TECH MIMICRY

Ten communications packages that allow the IBM PC to emulate popular terminals

My family and I recently returned home from a week-long visit in Florida at the "Temple of Tall Tales and Technology." My daughter, who is slightly more than a year old, has a whole new perception of reality. To her, I'm sure, a typical afternoon now includes leaping through hyperspace to Mars, trying to separate a world-famous rodent from his nose, and dancing with an overgrown duck (Donald's 50 years old this year). In contrast, her ordinary life at home will seem like sensory deprivation.

I was intrigued by the myriad impersonators and impostors we saw and heard: Audio-Animatrons, puppets, fiberglass models, and people decked out in animal suits, all pretending to be something they're not. This article examines some impersonators in the microcomputer

Augie Hansen is a programmer for a major telecommunications company. He wrote Chrome Ranger, a game for the IBM PC.



world: communications packages that include terminal emulation among their capabilities.

Recently I've been calling such packages by a new name, which was an unwitting creation of Carole Autenzio, *PC Tech Journal*'s editorial assistant. She got tired of saying "terminal emulators" during our frequent conversations and subconsciously shortened the phrase to "termulators"; I've been using that marvelous contraction ever since.

Each of these "termulators" can make the IBM PC masquerade as a terminal of at least one well-known model. Some can do as many as six impersonations, which qualifies them for the terminal emulator equivalent of the Rich Little act-alike award. One package even calls itself the Impersonator.

The other programs reviewed are Omniterm2, PC/InterComm, direct.connect, Crosstalk XVI, SmarTerm 100, Communiqué, the IBM 3101 Emulation Program, and Relay. In addition, I've included information about a free program called SIMTERM that also does terminal emulation and is supplied with complete Pascal and assembly language source code.

I selected these terminal emulators for review because they mimic one or more of the widely used video terminals on the market. Most of the communications programs now on the market claim to emulate a "dumb" terminal, defined as a terminal that sends everything typed on the keyboard to the remote computer and dumps everything received to the console. This article examines emulations that are considerably more sophisticated, giving the user control over screen displays and possessing the ability to interpret keyboard commands and special functions.

Table 1 shows at a glance which terminals each of the tested programs claims to emulate. I examine each program's emulation capabilities and compare them to the real McCoys. Most of them do a decent job; some are superb.

Table 1: Summary of Terminal Emulations

PROGRAM NAME	LSI ADM3a	ADDS Regent	Hazeltine Esprit	IBM 3101	TVI 910/920-series	DEC VT100/VT52	TI 940	Custom
	EMULATED TERMINAL TYPE							
Communiqué				Y		Y		
Crosstalk XVI		Y		Y	Y	Y	Y	
direct.connect	Y							
IBM 3101 Emulation				Y				
The Impersonator	Y		Y	Y	Y	Y		Y
Omniterm2						Y		Y
PC/InterComm						Y		
SIMTERM	Y							
SmarTerm 100						Y		
Relay						Y		

Types of Terminals

Like people, terminals are not all created equal in appearance, intelligence, or station in life. The diversity is astounding. Broadly speaking, there are *dumb terminals* and *intelligent terminals*. Some manufacturers use the term *smart* to mean a medium level of intelligence, brighter than dumb but not as bright as intelligent. Others use *smart* and *intelligent* synonomously.

Dumb Terminals. It was not too many years ago that dumb terminals were not considered so dumb—they were the only game in town. In comparison to many terminals today, however, a typical dumb terminal can do very few things. In addition to displaying the next received character at the current cursor or head position, most dumb terminals can interpret a few ASCII control characters called *format effectors* to do backspace, form feed, line feed, tab, and other formatting

operations typical of simple character-by-character hard-copy printers.

Many of today's video terminals are essentially dumb terminals with cathode-ray tubes (CRTs) instead of print heads and paper. These are

often called *glass TTYs* in honor of their close operational resemblance to older printing Teletype machines. (The term *TTY* is taking on new meaning these days—Teletype is making some intelligent video terminals that don't look and act at all like their clanky ancestors.)

Smart and Intelligent Terminals. Generally speaking, an intelligent terminal is one that has local memory, some processing power, and peripheral interfaces to permit it to do tasks normally done by a host computer.

Many terminals use control (escape) sequences to set and report the cursor position, set video attributes, insert and delete characters or lines, clear the screen, and protect data-entry fields. By themselves, in my view, these editing capabilities do not qualify the terminal to be considered smart or intelligent.

Of course, that's a debatable stand. There is really no consensus on what separates the morons from the merit scholars among terminals. I conducted an informal poll of about 30 programmers, hardware designers, and marketers. Most agreed that an ADM3a is a dumb terminal. Beyond that, there was little agreement on anything.

Try this as a starting point for further discussion. A smart or intelligent terminal earns its higher IQ rating based upon how well it does the following tasks (in addition to editing): manipulating data; range-checking and validation; blocking, compressing, and storing data; calculating; searching; communicating, including transferring files; printing; and more. An intelligent terminal is, in essence, a special-purpose computer system.

The bibliography cites some documents that try to define what an intelligent terminal is, with varying degrees of success. My as-

sertion above is most in line with the description given in *Intelligent Terminals: Functions, Specifications, and Applications* (Bernstein and Kashar, 1978).

Terminal Emulation

The ability to emulate terminals is important when the user is communicating with hosts that run full-screen editors, spread-sheets, and other programs that require tight control over what goes where on the screen. Some dumb terminals are marginally useful for such tasks but put a tremendous burden on the host computer. Others—those that lack cursor addressing—are virtually useless for such purposes.

Giving the terminal some "brains" solves some of the problems. It is of little value, however, to add intelligence to a terminal if the host computer doesn't know how to interact with it. Many minicomputer and mainframe operating systems keep a database of terminal capabilities, so that if the user is running a full-screen editor application, and the host knows he is using a VT100 terminal, the host can interpret special keyboard functions and can manage the screen effectively. In other situations, the editor may be in the terminal's memory, thus completely off-loading from the host any interactions during the editing session.

The following material is a summary of my tests and evaluations of terminal emulation programs for the IBM PC that try to fool a host computer into thinking the communicating machine is one of the popular terminals listed.

VT100-series Emulations

Digital Equipment Corporation has sold large numbers of VT100 terminals throughout the world. This terminal has two things going for it: it incorporates a VT52 mode so that the large base of existing software

for that popular terminal can be run without change; and it was the first to conform, in a manner of speaking, to the ANSI standards for terminal devices. For a long time, it was one of only a few terminal types to do so. (See the sidebar on ANSI standards for terminals.)

The VT100 implements only a subset of the ANSI standard func-

tions, and it adds many "DEC Private" functions that are not part of the standards. It is, however, one of the most popular terminals ever produced, so emulating it is sensible.

Table 2 is a summary of VT100 emulators and the features each supports. Virtually all of the programs tested that have a VT100 emulation incorporate a VT52 mode. The SmarTerm 100 and PC/InterComm programs also emulate the VT100 set-up operations. None of the programs tested claims to do the double-high and double-wide line displays, but PC/InterComm simulates them by spacing displayed lines horizontally and vertically. Omniterm2, PC/InterComm, Communiqué, and SmarTerm100 add the editing features of the VT102 or VT132 terminal—insert/delete character and line, and replace (overstrike) mode—that are missing from the basic VT100.

All of the packages tested fail to perform some VT100 functions as a result of the hardware limitations of the IBM PC. For example, none of them permits separate transmit and receive speeds because the IBM asynchronous communications card won't support that. None supports the graphics mode of the VT52. Such features as the RS-232 port status report are not applicable.

Each of these products uses color on displays that support it. PC/InterComm allows the user to switch between display adapters during execution. All the others use the monitor that was the default at the time the program was loaded. SmarTerm 100 will handle the 132-column screen with a SuperVision display adapter board made by California Computer Systems.

Crosstalk XVI and PC/InterComm implement the reverse video screen mode of operation perfectly. SmarTerm handles the mode acceptably from the set-up form but not when under control of the host computer. It is necessary for a clear-screen command to be sent to make

Table 2: Comparison of VT100 Emulators and VT100 Terminal

VT 100 TERMINAL FEATURES	EMULATOR PROGRAM							
	Crosstalk XVI	Impersonator	Communiqué	Omniterm2	PC/InterComm	SmarTerm 100	Relay	
Terminal Setup Screen Forms	No	No	No	No	Yes	Yes	No	
Cursor Type UL/Block Select	UL	UL	UL	UL	Yes	Yes	No	[Setup form]
Response to "What Are You?"[1]	NOP	NOP	NOP	NOP	AVO + GPO	AVO	AVO	
PF1-PF4 Keys Simulated	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
80/132 Columns	No	No	No	No	No	[2]	No	
VT52 Emulation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
ANSI/VT52 Selection	Yes	Yes	No	Yes	Yes	Yes	Yes	
Scrolling Region	Yes	No	No	Yes	Yes	Yes	Yes	
Smooth Scroll	No	No	No	No	Yes	Yes	No	["slow scroll"]
Cursor Keys on:								
Numeric Keypad		Yes	Yes		Yes	[3]	Yes	
Function Keys					Yes	Yes	No	
<Alt>+<top row>	Yes			Yes				
Reverse-screen Mode	Yes	No	No	No	Yes	Yes	No	
Margin Bell ON/OFF Select	No	No	No	No	Yes	Yes	No	[Setup form]
Wraparound ON/OFF	Yes	No	Yes	Yes	Yes	Yes	No	
Settable Tabs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
VT102/132 Extensions	No	No	Yes	Yes	Yes	Yes	No	
Select Graphic Rendition (SGR)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	(Some combinations are not possible.)
Screen Alignment Test	No	No	No	No	Yes	Yes	No	
LED Display	No	Yes	No	No	Yes	Yes	No	
BREAK Signal Key Provided	Yes	Yes	Yes	Yes	Yes	Yes	No	

1 NOP-No Options; AVO-Adv. Video Option; GPO-Graphics Processor Option.
2 Requires SuperVision display adapter card.
3 <Shift>+<arrow> required to move cursor.

the mode take effect, and doing that makes the user lose the context of the work in progress.

The other programs do not emulate the reverse-video screen, although they can be tricked into it if the user sends the SGR 7 mode command (Select Graphic Rendition—reverse video) and a clear-screen command. I think the reverse-video screen looks garish, but a lot of people seem to like it.

All of the programs send the DEC sequences assigned to the PF1-PF4 function keys, using the IBM PC function keys F1-F4 to do so. The remaining function keys (F5-F10) and their Shift-, Alt-, and Ctrl-key alter egos are used for cursor positioning and switching contexts within the communications program. They usually may be assigned to any purposes the user desires, as long as that purpose is within the capabilities of the hardware. Only Relay is an exception in this regard. It uses the Alt-F1 through Alt-F4 sequences to simulate the VT100's PF1-PF4 keys (because F1-F4 are permanently assigned to other tasks).

IBM 3101 Emulations

In a dramatic departure from the IBM world of computer communications, in which EBCDIC reigns supreme, IBM introduced the 3101 ASCII terminal. (The PC is also an ASCII-oriented device.) The 3101 is a lovely terminal in many ways. It has a fine "Selectric-style" keyboard, a screen that is easy on the eyes, and some nice terminal features—all in all an attractive package. Most of the terminal options are chosen through set-up switches that are accessible to the user.

IBM sells a 3101 emulation package for the PC and XT that comes as close to the real thing as one could expect given the hardware differences between the machines. It is obviously the reference program for this comparison.

None of the 3101 emulators allows the use of transparent and local modes. The IBM program modifies some functions, such as Set Control, to exclude control-code bits that are not necessary. The Set Control function is not necessary by the other programs because they do not implement block mode. None of the programs supports any foreign-language features.

Table 3 is a summary of the IBM 3101 emulators tested. Except for the IBM program, which implements some of the block mode features, the programs are nearly the same from an operational perspective. The Impersonator is much the easiest of these programs to use.

TeleVideo 910/920 series Emulations

TeleVideo has been producing smart terminals for a number of years and has recently moved into the microcomputer field as well. The company's terminals have always been packed with many features for the money. As a user of terminals, I appreciate the pains taken by TeleVideo to provide a high degree of "functionality," especially in the area of video attributes and control capabilities.

In its efforts to keep the cost low, TeleVideo made one design decision I wish it hadn't: the company used a video memory that is only 1,920 bytes small and a brain-damaged video controller.

In its efforts to keep the cost low, TeleVideo made one design decision I wish it hadn't: the company used a video memory that is only 1,920 bytes small and a brain-damaged video controller. That memory size contrasts poorly with the 4K bytes in the PC's display memory for one screenful of characters and attributes. Each even byte in the PC's display memory holds a character code (one of 265) and each odd byte holds the video attribute of its corresponding character.

To control the video attributes on its screens, TeleVideo uses what have been dubbed "magic cookies" in display memory. No, these are not brownies laced with a controlled substance; they are bytes of display memory that hold special codes to set video attributes. These attributes have effect from the time they are first set until they are cleared. The bytes used for this are effectively stolen from the bytes otherwise used to store displayable characters. To work with display memories that use "magic cookies," programmers must go through all kinds of gyrations to write code that can manage screen displays correctly. Programs that emulate TeleVideo terminals need to account for this difference in display memory implementation.

An example of the differences that must be considered in writing an emulation program is the way the functions that clear to the end of a line are implemented. The TeleVideo terminal allows two methods: the erased characters can be converted either to spaces or to nulls. The emulations treat both methods identically and just pad the memory buffer with spaces in the prevailing attribute.

The Impersonator and Crosstalk XVI provide TVI910/920-series emulations. Again, Crosstalk provides a prepackaged set-up that cannot be modified. It combines the features of the 910 and 920 terminals. The Impersonator implements most of the features of the 912 terminal. For all the purposes I found for using this terminal emulation, the two programs are nearly identical. On systems that have databases of terminal capabilities, specify the tvi912c entry—it seems to be op-

timum for both the Impersonator and Crosstalk XVI when these programs are used with screen editors and similarly demanding applications programs. Be sure to specify the "c" suffix, because early TeleVideo terminals were incredibly slow at certain operations, such as scrolling the screen up, and they required lots of padding to accommodate their sluggishness.

Neither the Impersonator nor Crosstalk XVI implements the block and protect mode operations available with the 910/920 series. Also, neither specifically sets up the function keys of the 920 terminal. Crosstalk allows the user to customize the IBM function keys; the Impersonator avoids the problem by simply not claiming to emulate a 920. Special editing, function, and transmission keys are primarily what distinguish the 920 from the 912.

Lear Seigler ADM3a Emulations

The LSI ADM3a terminals are a bit like pennies. They're found everywhere, and they continue to serve even when old and tarnished. About five years ago I walked into a computer facility that had just received about a hundred of these light-blue-encased, one-eyed monsters; they were arrayed, rank and file, like a small army awaiting orders. I felt lucky to escape unscathed and have had a hard time feeling comfortable using one of them ever since that encounter. Of course, they are very dumb and rather slow, which may also play a part in causing me to feel as I do. Despite these drawbacks, the ADM3a has been a workhorse in the computer industry for years, and many programs will run on these terminals easily.

Three of the programs reviewed include an ADM3a emulation. The direct.connect program and SIMTERM, at least in their current versions, emulate nothing else. The Impersonator also pays homage to this electronics beast of burden burden.

There is nothing particularly tricky about the LSI ADM3a terminal or any of its emulators. Aside from allowing the user to clear the screen, position the cursor, and perform a few other functions, the terminal basically behaves just as a printing terminal does, except that it uses a CRT screen instead of paper. All of the emulations worked as they should while running editors and other programs that required, as a minimum, cursor positioning.

Miscellaneous Emulations

Time did not permit testing of the remaining three emulations. The creators of the Impersonator state that it can pretend to be a Hazeltine Esprit, a rather nice video terminal that is finding its way into computer facilities and offices. Crosstalk, in addition to the emulations already described, is supposed to be able to function as an ADDS Viewpoint and as a TI 940 terminal.

Table 3: Comparison of IBM 3101 Terminal and Emulators

	EMULATOR PROGRAM			
3101 TERMINAL FEATURES	**Crosstalk XVI (Model 10)**	**IBM 3101 Emul. Pgm. (Model 20)**	**The Impersonator (Model 10)**	**Communiqué (Model 10)**
Set Tab	Yes	Yes	Yes	Yes
Clear Tab	Yes	Yes	Yes	Yes
Back Tab [B]	—	Yes	—	—
Start Field [B]	—	Yes	—	—
Read Cursor Address	Yes	Yes	Yes	Yes
Read Buffer [B]	—	Yes	—	—
Set Control	No	Yes [*]	No	No
Cursor Motion Control Codes	Yes	Yes	Yes	Yes
Write Send Mark [20]	—	[!]	—	—
Cursor Home	Yes	Yes	Yes	Yes
Erase to EOF/EOL	Yes	Yes	Yes	Yes
Erase to EOS	Yes	Yes	Yes	Yes
Erase Input	No	Yes	Yes	Yes
Clear All	Yes	Yes	Yes	Yes
Insert Line [B]	—	Yes	—	—
Delete Line [B]	—	Yes	—	—
Insert Char. [B]	—	Yes [%]	—	—
Delete Char. [B]	—	Yes	—	—
Cancel [20]	—	[!]	—	—
Print Line [20]	—	[!]	—	—
Print Message [20]	—	[!]	—	—
Print Page [20]	—	Yes	—	—
Set Buffer Address	Yes	Yes	Yes	No
Set Cursor Address	Yes	Yes	Yes	Yes
Insert Cursor	Yes	Yes	Yes	No
Lock Keyboard	Yes	Yes	Yes	Yes
Unlock Keyboard	Yes	Yes	Yes	Yes
Function Keys (PF1–PF8)	Yes	Yes	Yes	Yes
Transparent Mode	No	No	No	No
Block/Char. Mode Select	—	Yes	—	—
Norm/Trans/Prgm Mode Select	—	Yes	—	—
Erase Keys (4) Simulated	No	Yes	No	No
Cursor Motion Keys Enabled	Yes	Yes	Yes	Yes
Local Mode Operation	No	No	No	No

[B] → Block mode only
[20] → Model 20 only
[*] → Some bits always set or ignored
[!] → Not supported
[%] → Canadian French not supported
— → Not applicable

Custom Emulations

Two of the emulator programs—the Impersonator and Omniterm2—will permit users to extend their capabilities if they dare or are pressed hard enough to try. These programs make extensive use of input and output filtering and translations to do their emulations. Both emulators make those capabilities available to the user through the use of various menus and work screens.

The concept is deceptively simple: every key press sends a code that can be passed through unmodified or captured and translated into a local action or a sequence of codes to be sent out. Similarly, a character being received may be passed or converted. Even patterns may be captured and translated. With a programming language of decision statements and actions, it is possible to do many interesting emulations.

Of the two packages, the Impersonator is far more sophisticated in the way it handles the preparation of emulations and in the breadth of its capabilities. More features are also being added. Owners of the current version will be treated to a free update that will speed up some operations and increase the flexibility of the actions that can be taken, making possible more block-mode emulations and other extensions.

Figure 1 shows a work screen from the Impersonator that exemplifies the clean method used to display and modify translation tables and other configurable elements.

Users who decide to "roll their own" emulations should be prepared to do much experimenting and to pad their walls with something soft; there are many subtle interactions and "gotchas" lurking about in terminals.

Conclusions

Besides the terminal-emulation aspects, these programs also have other general communications capabilities; I did not, however test any of these features. In each case, a full set of capabilities—including file transfers, local printing, and general access to bulletin boards and information services—is promised.

On the whole, the quality of the documentation provided ranges from good to excellent. The manual provided with the Impersonator is complete and nicely produced, but it needs better organization in some areas and better coverage of the emulations that are provided. The direct.connect package has well-written documentation that benefits from tabbed section dividers. The documents that accompany PC/InterComm and IBM 3101 Emulation Program are the most thorough in describing what their programs do. PC/Intercom's manual is neat and well written, but the type size may be a bit small for old eyes.

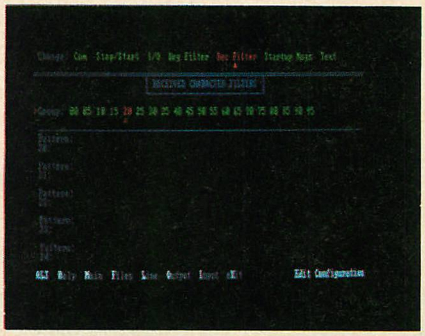
Communiqué is a new product, and its lack of maturity shows clearly when it is compared with some older products. It has good potential, particularly for use in a UNIX environment in which the extra tools provided with the package aid in handling multiple file transfers and other functions. Its documentation is currently in a comb-bound booklet that has the look of UNIX documentation. It measures 8½ inches by 11 inches, unlike all the others, which come in the familiar half-size format.

Only one of the programs tested, SmarTerm 100, is copy protected. All the others may be backed up freely and placed on hard disks. Persoft provides two complete copies of the program diskette, and each may be used once to transfer needed files to a hard disk. If a registered user needs to update or replace a hard disk more than twice, Persoft will describe how to do it. I don't like to see software of this type copy protected because of the inconvenience it causes end users. To its credit, however, Persoft has been helpful on the phone and has tried to minimize the adverse effects of copy protection.

On the basis of VT100-series emulations alone, I'd choose either PC/InterComm or SmarTerm 100. For users who need a range of general-purpose emulations and the potential to expand to others essentially at will, the Impersonator looks hard to beat.

For overall versatility and general use, Crosstalk and Omniterm2 are both strong contenders, but don't rule out any of these programs. Competition in the field of terminal emulation is becoming so fierce that it is hard to find a really bad product. Of course, that situation is good for you and me.

Photo 1: The Impersonator Displaying a Work Screen Used to Set Up Translations.



References

Bernstein, George B., and Arnold S. Kashar, *Intelligent Terminals: Functions, Specifications and Applications*, Q.E.D. Information Sciences, Inc., 1978.

Guide to Intelligent Terminals, AUERBACH, 1976.

Vital Statistics

Communiqué
Computerized Office Services, Inc.
313 North First Street
Ann Arbor, MI 48103
313-665-8778
Languages: C and Assembly Language
$195
CIRCLE 495 ON READER SERVICE CARD

Crosstalk XVI
Microstuf, Inc.
1845 The Exchange, Suite 140
Atlanta, GA 30339
404-952-0267
Language: Assembly Language
$195
CIRCLE 499 ON READER SERVICE CARD

direct.connect
Direct.aid, Inc.
P.O. Box 4420
Boulder, CO 80306
303-422-8080
Languages: Microsoft Pascal and Assembly Language
$95
CIRCLE 498 ON READER SERVICE CARD

IBM 3101 Emulation Program
IBM
Boca Raton, FL 33432
305-998-2000
Languages: IBM Pascal and Assembly Language
$140
CIRCLE 497 ON READER SERVICE CARD

The Impersonator
Direct.aid, Inc.
P.O. Box 4420
Boulder, CO 80306
303-442-8080
Languages: Microsoft Pascal and Assembly Language
$195
CIRCLE 496 ON READER SERVICE CARD

Omniterm2
Lindbergh Systems, Inc.
49 Beechmont Street
Worcester, MA 01609
617-852-0233
Language: MMSFORTH
$245
CIRCLE 495 ON READER SERVICE CARD

PC/InterComm
Mark of the Unicorn, Inc.
222 Third Street
Cambridge, MA 02142
617-576-2760
Languages: Lattice C and Assembly Language
$99
CIRCLE 494 ON READER SERVICE CARD

Relay
VM Personal Computing
60 East 42nd Street
New York, NY 10165
212-686-1450
Language: Assembly Language
$149
CIRCLE 491 ON READER SERVICE CARD

SmarTerm 100
Persoft, Inc.
2740 Ski Lane
Madison, WI 53713
608-273-6000
Languages: Compiled BASIC and Assembly Language
$150
CIRCLE 493 ON READER SERVICE CARD

SIMTERM
Jim Holtman
5 Dogwood Trail
Randolph, NJ 07869
Languages: IBM Pascal and Assembly Language
Free (send diskette and mailer with adequate return postage)
CIRCLE 492 ON READER SERVICE CARD

The Standards Issue

Given the utter chaos in the field of computer terminal devices, it would seem that the standards promulgated by the American National Standards Institute (ANSI) have been forgotten. For a long time, only a handful of terminal devices conformed to the standards, and then only loosely. Most terminal manufacturers chose to follow their own courses, hoping that one or more of their product's great features would attract more buyers than the features of someone else's terminal would.

The situation is improving, though. Many of the terminals introduced in the last few years have adhered at least partially to the standards—enough, at any rate, to allow the manufacturers to call them ANSI-compatible. That compatibility is, however, largely an illusion.

What Standards?

There is a set of American National Standards that attempts to bring some order to a relatively chaotic scene. It is the result of work done by the X3 Committee, more formally known as the *American National Standards Committee on Computers and Information Processing, X3*. Three of the standards applicable to this discussion are X3.4, X3.41, and X3.64. These deal primarily with codes and character sets, formatting, and basic control functions. Others that apply specifically to data link control issues are also available.

The standards are voluntary and have about the same force as resolutions of the United Nations General Assembly—few people pay attention to them, but we all sleep a little better at night knowing someone cares. It is fortunate that the standards, especially X3.4, have had greater effect on the communications industry than most UN resolutions have had on governments.

ANSI X3.4-1977. This document defines the 7-bit character representations for control and graphic characters that we so blithely refer to as ASCII. The control characters are nondisplay items that control the communication process and format the printing or displaying of information. The latter are called "format effectors" and include horizontal and vertical tabs, carriage return and linefeed (or newline), form feed, etc. Of the three documents discussed here, this is the most useful and the most respected by the industry.

The 1977 standard (denoted by the "-1977" appended to the base number) is an updated version of the original 1968 standard. Action must be taken within five years of the publication date of a standard to reaffirm that standard, revise it, or scrap it, so the documents should not become too outdated.

ANSI X3.41-1974. It didn't take the people who wrote the standards long to realize that the number of unique codes that can be expressed directly by a 7-bit code is too small to handle the wide variety of control and graphic requirements of computer users. Something had to be done, and it was. In fact, it was anticipated in the definition of ASCII codes. Four codes were assigned a special purpose: code extension.

This document describes 7-bit code extension techniques, clever ways to make a 7-bit quantity have more meaning than the normal 128 permutations of its bit values. The techniques center on the use of four special-purpose codes. The Shift In

(SI) and Shift Out (SO) codes are used to switch between alternate graphic character sets. The Escape (ESC) control code prefixes sequences of a limited number of characters to provide a wide range of additional control codes. The Data Link Escape (DLE) code is similar to ESC, but it provides a means of creating supplementary data transmission control functions.

X3.41 does not define precisely what specific control sequences mean. Instead, it reaffirms the original ASCII control and graphic codes, labeling the sets CO and GO respectively, and gives some general guidelines on implementing alternate sets of control codes and graphic codes (C1 and G1), as well as multiple-byte GO sets if more than 94 characters are needed. This document also defines how to switch between the various character sets and describes methods of creating escape sequences of 2, 3, and *n* characters.

The document also deals with 8-bit codes and ways of applying a "family concept" to the definition of codes for compatibility with the 7-bit codes and for doing code extensions in the 8-bit framework. X3.28-1971 defines the purpose and use of nine data link control characters plus the DLE character, which is used in constructing additional sequences of data link control codes.

ANSI X3.64-1979. This document attempts to define escape sequences for specific purposes, such as positioning a cursor, clearing the screen of a display terminal, and many others. It must be one of the most confusing sets of instructions ever developed. It is not possible simply to look up a function in a table to see what its escape sequence should be. Instead, to piece together a control sequence, it is necessary to follow a set of "rules" that is strikingly similar to the instructions in some adventure games. This provides plentiful opportunities for confusion and error, and many terminal designers have made errors of interpretation.

X3.64 is a "living" document in that it describes procedures for a registry of escape sequences and their meanings, except for what are considered "private" escape sequences. The registration of sequences tries to guarantee that items that should be used identically by everyone are in fact used in that way, and that those that must be unique are unique.

Information, Please

Information about the status of ANSI standards and copies of individual standards documents may be obtained by writing or calling the American National Standards Institute, 1430 Broadway, New York, NY 10018, 212-354-3300. The Institute also provides information about standards published by the International Organization for Standardization (ISO). A catalog costs $10; individual documents vary in price.

—AH

The No-cost Alternative

When the range of commercial communications programs for the IBM PC could be counted on two fingers, Jim Holtman and his son Eric wrote their own in Pascal. They called it SIMTERM, a euphemistic concatenation of *terminal simulator*. It was the Holtmans' original intention that SIMTERM be used mainly in the UNIX environment, and because of that, its user interface was strongly biased toward programmers.

The original program had two remarkable features in addition to its generally useful operational features: it was free, and it was supplied with full Pascal and assembly language source code in addition to the executable programs. The user was not even requested to send money to the authors if he liked and used the program. There was, however, one catch—the user had to provide the needed RS232INT.BAS file (or, for ACS version 2.0, RS232INT.EXE.

As time passed, features were added, bugs fixed, and the needs of other users were accommodated. The latest version includes a lot of nice enhancements, including XMODEM protocol file transfers, support for bulletin board users, command script files, remote access and control, and Ventel auto-dial modem support. It's still free, and it now includes its own machine language interface module, so the user no longer has to be a registered owner of IBM's ACS package to use SIMTERM legally.

SIMTERM is comparable to many commercial programs, and it has some nifty features. Here is an abbreviated list of the program's main features.

- Fully configurable (from command line)
- Log session to printer and/or disk
- XON/XOFF flow control (may be disabled)
- Programmable function keys (from key definition file)
- Supports multiple COM ports and IRQ levels
- Direct connect option for hard-wired lines
- Command script files
- Remote access and control operation
- Uses all available memory as a scrollable session buffer
- Has many options for file processing and printing
- Upload/download (three varieties, including XMODEM)
- On-line help (context-dependent help frames)
- Exit to DOS with hang-up and no-hang-up options
- Hang up line without exiting to DOS
- Local line editing and retransmission
- Ventel auto-dial modem support
- Character-graphics mode option (bit 8 enabled)
- Terminal emulation (LSI ADM3a)

I have used the program with Hayes external and built-in modems, the U.S. Robotics Password modem, and standard 212A- and 103-compatible modems wihout difficulty. The user will have to flip a few switches on some of the modems; information about this is provided in a 12-page "readme" file on the distribution disk. Because the Holtmans have the Ventel modem, they designed for it rather than the Hayes. If they receive enough requests for Hayes support, it will be added. They got my request already.

There is a growing interest in SIMTERM, especially in the university community. Many universities run the UNIX operating system on their main computers and are setting up PC labs, using IBMs and workalikes in addition to other equipment. SIMTERM gives the schools a painless way to connect the PCs to the main computers. A public domain program called UMODEM can handle the UNIX end of XMODEM file transfers, so all the pieces are available at little or no cost.

If you want a copy of SIMTERM, first try a friend or computer club that may already have the program. If that doesn't work, send a formatted diskette in a suitable mailer with return postage to:

Jim Holtman
35 Dogwood Trail
Randolph, NJ 07869

Jim and Eric get nothing from this except the satisfaction of knowing others use and enjoy their program. If you don't really need it, please don't waste their time.

—AH

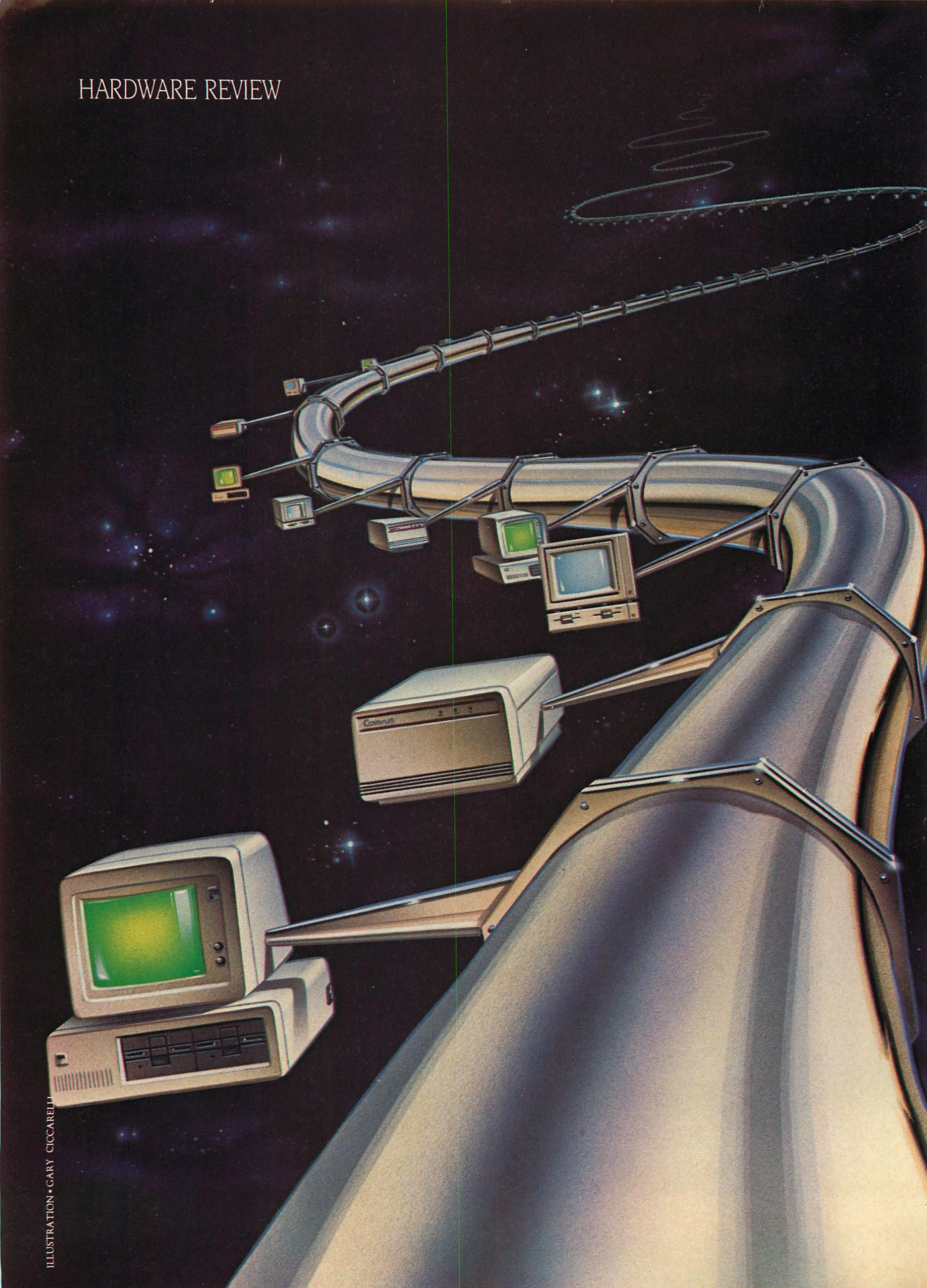


ILLUSTRATION • GARY CICCARELLI

OMNIUM GATHERUM

Corvus Systems' Omninet can support a miscellaneous collection of computers in the same network.

Corvus Systems' Omninet is the grand old man of microcomputer networks. It began its electronic life by connecting Apple II and TRS-80 computers and has since evolved into the network community's equivalent of the intergalactically renowned (at least to readers of Douglas Adams' *Hitchhiker's Guide to the Galaxy*) babblefish.

Omninet is designed to interconnect a variety of microcomputers, all of which can be running under different operating systems. When each computer is provided with network hardware and drivers appropriate to the particular machine, they are all able to share a central disk server, mass storage devices, printers and other peripherals. *PC Tech Journal* has a Johnny One-Note variety of microcomputers available for testing, and therefore we were able to evaluate network performance only on IBM PCs.

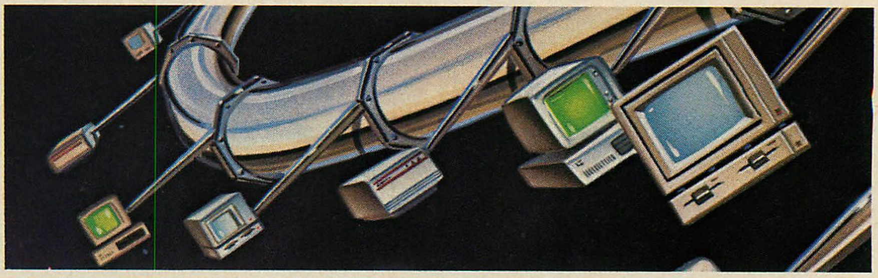
SUSAN GLINERT-COLE AND JULIE ANDERSON

The operating systems that are presently supported for the PC are DOS 1.1, 2.0, and 2.1. Although Omninet is written in UCSD Pascal, no drivers are provided for either the UCSD p-System or any version of CP/M. Minimum requirements for a user station are one disk drive and 64K of memory. The station used to generate the network system and set up the server software needs 128K and one disk drive. Omninet uses stand-alone disk servers for sharing mass storage, and to implement spooling it uses either a separate print server, which can service one parallel and two serial devices, or an IBM PC with a printer.

Omninet is not inexpensive. The server ranges in price from $1,995 for a 5-megabyte disk to $4,995 for a 45-megabyte disk. Each station requires a transporter card that costs $495. Print spooling and back-up facilities run the price up even more: the printer server is $990 and the bank tape back-up costs $2,195. Neither the trunk cable nor the printer cable come with the package.

The network is a CSMA system and uses RS-422 twisted-pair wire in a linear bus configuration for both the trunk and drop cables. Connections between the drop and main cables are made by means of transceivers that are housed in small plastic boxes. The length of the trunk cable cannot exceed 4,000 feet. Network throughput speed is one megabaud per second.

All of the devices on the network—hard disks, print servers, and computers—have individual transporter boards installed to handle communications; each board is set to a unique address. As many as 64



devices can be linked together into an Omninet system. The network uses no interrupt or DMA channels; it uses I/O ports 248h to 24Bh.

The Omninet package provides the services of the four lower layers of the ISO/OSI protocol. The upper three layers are supplied by Corvus for each machine. Corvus reserves the word Omninet for the lower four protocol layers only and uses the designation Constellation II to mean the higher-level network software. We will refer to the entire system as Omninet, because that name is generally more familiar to the computer community.

All transporter boards are identical in nature; no master network controller is required. The transporter is responsible for generating and receiving message acknowledgments, retransmitting messages in the absence of acknowledgments, and detecting duplicate messages.

Table 1: Currently Supported Omninet Commands

INITIALIZE	Initialize transporter (automatic at power-on)
SEND MESSAGE	Send a message to a specific node or broadcast to all nodes
SETUP RECEIVE	Prepare to receive a message
END RECEIVE	Stop receiving messages
WHO AM I	Return node ID number
ECHO	Check for the existence of a specified node
PEEK/POKE	Set transporter parameters (e.g., number of retries)

FILE OR MESSAGE TRANSFERS

When the transporter has a packet ready to send, it checks the transmission line for traffic. If the line is idle, transmission proceeds. Otherwise a random delay count is generated, after which transmission is again attempted. The process is repeated until the line is idle, or until the number of retries exceeds the limit set internally. Collision detection is not required.

From the host's point of view, the unit of transfer is a single message. To send a command to the transporter, the host computer formats a command vector in memory and sends the address of that vector to the transporter. The transporter converts the message into a data packet by adding system information and then converts the packet to a synchronous serial bit stream and sends it out over the network. Currently, Omninet implements seven commands (see table 1).

Only one message can be sent at a time, but up to four can be received simultaneously. Four sockets in the transporter are activated by a unique vector that contains the SETUP RECEIVE command; these sockets thus operate independently. Messages are split into a user-data portion and a user-control portion, and each is assigned its own host computer memory buffer area by the SETUP RECEIVE command for that particular socket.

Network devices initiate commands by sending 3 bytes, which represent a 24-bit address, to the local transporter. This address contains the command vector, which includes a command code, a result-record address, and other information required to process the command. After the command has been

executed, the transporter signals the host by altering the result record. Computers that support interrupts will generate one after the result record has been modified.

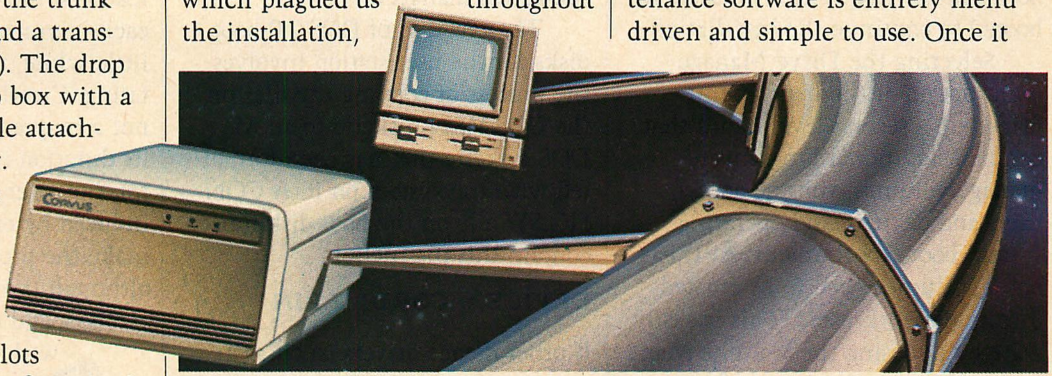
Disk servers have limited buffer space; disk commands longer than 4 bytes are sent in two parts. The first transfer sends the first 4 bytes of one disk command to the server. The host computer waits for a "GO" response from the server before it sends the rest of the command. The server can queue one request for each network device.

System Set-up

The hardware set-up for Omninet is reasonably simple in concept: each device in the network must have a transporter board installed and set to a unique address. Corvus devices, such as the disk and utility servers, come with the transporter hardware already installed.

Each device is connected from its transporter board to the trunk cable by a drop cable and a transceiver (called a tap box). The drop cable plugs into the tap box with a jack, but the trunk cable attachment is a little trickier. The outer shield of the trunk cable must be carefully stripped, so as not to cut the inner shielding, and the cable placed into two slots in the tap box. It takes a fine, steady hand with a knife, razor blade, or pair of wire strippers to accomplish this. The bus must be terminated with two resistors, which are not included in the price of the network. (We got ours at Radio Shack for 39 cents.)

The hardware documentation is, for the most part, clearly written, but it is not well organized. Each device comes with its own manual; another manual contains the instructions for installing the software; and the transporter boards come with a separate pamphlet detailing the set-up of the boards, cables, and tap boxes. There are no indices in some of the manuals, and we often had three of them on our laps simultaneously while attempting to diagnose a problem.



Several omissions and errors caused considerable installation problems. One error was serious enough to make installation impossible as described. A picture of the address dip switches shows all the switches UP as address 00. Unfortunately, this is backwards; all switches UP should be address 63. When the system-generation program asked for the address of the server to be installed, it found no server with address 00; the system hung and had to be rebooted.

This problem would not have been as serious if all of the switch settings were consistently incorrect. In fact, they were correctly described in some places (in the pamphlets for the transporter boards, for example). The dip switch problem, which plagued us throughout the installation, caused us to coin our Omninet Motto: What goes up, must be down.

The most irritating aspect of the installation process was the lack of meaningful error messages and, in some cases, the absence of any error messages at all. Although the system does present error codes on occasion, there was no table of error messages in the documentation. Also missing were several errata sheets that were essential.

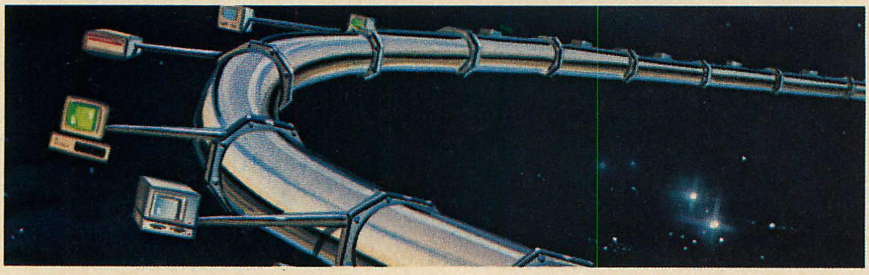
The main manual is divided into four sections: system generation, system manager's guide, network station user's guide, and OmniDrive Diagnostic Guide. As in all of the hardware manuals, these sections are organized in a "paint-by-number" scheme: follow each step in the guides, and the installation is complete when all the numbers have been used up. This would have been a satisfactory presentation had everything gone smoothly. When problems occurred, however, it was less than satisfactory. There are few, if any, problem-determination procedures other than "Contact your Corvus representative."

The software comes on four diskettes, three of which are the p-System software kernel. The fourth contains PC-DOS drivers and the user-station software for managing volumes and performing print spooling functions. Corvus maintains that the Omninet diskettes are not copy protected, but we were unsuccessful in making back-ups for two of the three p-System disks.

The system set-up and maintenance software is entirely menu driven and simple to use. Once it was correctly installed, we had no problem with the software.

Software installation is begun by booting the system-generation diskette, CORMS21, and entering the system password provided in the manual. The initial menu presents several choices: Initialize Drive, Drive Management, Maintenance Utilities, Configure System, List Drives, and Help. All disk servers on the network must be initialized before installation can proceed. When the drive initialization option is selected, another menu appears that asks the user to name the disk

server, create a server password, name the drive, and create a drive password. The standard configuration allows up to 512 users, 512 volumes, three computer types, and



four Omninet disk servers. If these parameters are not satisfactory, or if Apple II computers will be part of the network, other configurations can be designated.

Once the drive(s) have been initialized, the Omninet software copies system files from the floppy disk drive to the Corvus Volume. The entire process is well prompted from clear menus and takes about 30 minutes. The system must be rebooted to continue the installation.

Selecting the Drive Management option at the main menu brings up a second-level menu that contains additional programs to manage volumes, volume access, users and devices, and operating-system boot environment. At this point, volumes need to be created for the network users. This is easily done by choosing the Volume Manager option; another menu floats to the top. Volumes are created with a name, size, and operating system type. Adding volumes is done by repetitively pressing a few keys until the disk runs out of space, the user runs out of patience, or all desired volumes have been created.

Privacy protection in Omninet is implemented by granting selected access to a volume or volumes with the Access Manager. Access can be read-only or read/write. As many as 10 volumes can be automatically assigned to drive letters (called mounting) when the user boots the station software. These assignments of volumes are made when the user is granted volume access.

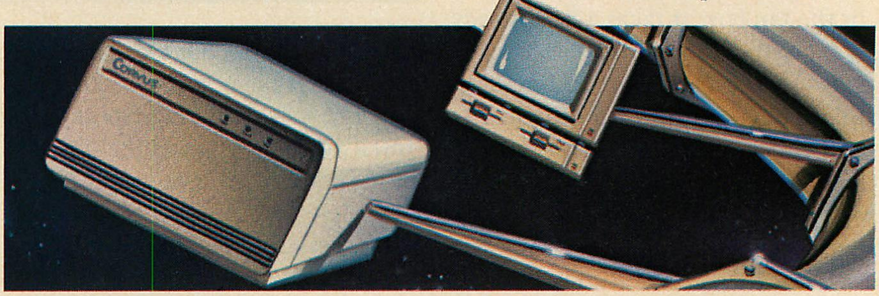
Interestingly, the manual, which contains an extensive walk-through of the installation procedure, grants the user access before the user is actually created. The system doesn't seem to care whether or not the user really exists.

Users are created with the User Manager facility. They are assigned a password, a home disk server, and a boot operating system. For obvious reasons, the user's boot operating system must agree with the volumes that have been mounted with the access manager.

The creation of DOS 2.0 boot disks for the user station involves the process of copying the files on the CORMS24 diskette to an MS-DOS diskette that has been formatted with the system on it. A CONFIG.SYS file on the boot disk must contain this instruction:

DEVICE = CORDRV.BIN

If other device drivers (such as a



RAM disk) are assigned to a drive letter, these device drivers should precede the Corvus driver in the CONFIG.SYS file. This procedure will mount all Corvus volumes on drive letters following those of the local MS-DOS device drivers.

For DOS 1.1, a custom BIOS interface routine containing the Corvus device driver is installed on the disk server. The boot disk receives a modified boot record that transfers control to that custom BIOS routine.

The system is rebooted with the user-station diskette, which presents the CORVUS sign-on menu and prompts for the user's password. When it has been successfully entered, any AUTOEXEC.BAT file is executed, and the familiar DOS prompt appears. All mounted volumes are accessible with drive letters beginning with the first one available after the local drives. For example, if a host computer has two floppies, a RAM disk, and a fixed disk, the first network volume would be mounted on drive E:.

Software set-up was easy (no dip switches here). Because it is written in p-System, however, the Omninet software goes back to the disk to load and initialize an overlay for each menu selection. After only a little while, the delays became irritating. Clearly, system installation is not a frequently performed task, so its duration is not a significant factor; however, repetitive installations induced by error conditions can make the process time-consuming, although the system manager would rarely spend several hours a day with the set-up utilities.

INFORMATION TRANSFER

File and message transfers, as well as print spooling, are implemented with a pipe area. This is a special volume, called PIPES, created in the mass storage system. All users who will be transferring information

must have access to this volume. Once the volume is created, users send files to the pipe area with the name of the intended recipient, which is designated as the pipe name. The pipe name can be another user, a local printer, or a device, such as the print server.

Files transmitted via pipes are a convenient way of converting files from one operating system format to another. Information can be retrieved from PIPES by using the DESPOOL program and naming the pipe for which to search. Files that are spooled to a print spooler are despooled automatically.

Internode spooling requires the purchase of the Omninet print server or a PC with an attached printer. Otherwise, users are limited to spooling to local printers or to the display. Although Corvus describes the PIPES volume as a message center, it was awkward to use.

The SPOOL and DESPOOL programs default to PRINTER as the name of the pipe to be used. Thus, in order to send a file or a message to another node, these programs must be reconfigured to reflect the change in pipe name. This change is not saved, which requires the sender or recipient to load the program and perform the change manually each time it is desired.

If a message is waiting in PIPES, the recipient is not informed; he or she must periodically check the volume for the correct pipe name. Although the user can despool to the printer, file, or console, the message is gone forever and cannot be repeated once it has been despooled.

This would not be critical if reasonable error checking were performed so that the recipient could change a disk or close the drive door. We despooled a message to a full disk by accident: the message was removed from the pipe by the despooler and tossed away.

Corvus markets a separate electronic mail package called OmniMail for use with the network. If message transfer is a priority for the network, the extra expense should be considered. (We did not receive OmniMail in time for our review.)

Table 2: Benchmark Results

	PC-DOS 2.0	1 user stn. 1	1 user stn. 2	2 users stn. 1	2 users stn. 2
I/O Benchmarks (in seconds)					
random access	0:06	0:08	0:07	0:16	0:14
sequential read/write	0:29	0:36	0:32	0:49	0:49
sequential read	0:14	0:16	0:15	0:24	0:24
dBASE sort, 1 key	0:40	0:42	0:42	0:51	0:47
dBASE index, 1 key	0:29	0:34	0:34	0:60	0:60
dBASE index, 2 keys	0:29	0:32	0:32	0:55	0:55
Word Processor Benchmarks					
WordPerfect:					
load wp from hard disk	0:04	0:08	0:08	0:15	0:13
load wp from floppy disk	0:14	0:11	0:10	0:11	0:11
exit wp (to hard disk)	0:01	0:04	0:03	0:05	0:04
load file from floppy	0:04	0:03	0:03	0:03	0:03
save file to floppy	0:18	0:19	0:19	0:19	0:20
load file from hard disk	0:02	0:03	0:03	0:04	0:04
save file to hard disk	0:15	0:16	0:16	0:20	0:20
WordStar:					
load wp from hard disk	0:06	0:06	0:07	0:08	0:08
load wp from floppy disk	0:07	0:07	0:07	0:07	0:07
exit wp (to hard disk)	0	0	0	0	0
load file from floppy	0:03	0:10	0:03	0:10	0:10
save file to floppy	0:32	0:33	0:33	0:34	0:34
load file from hard disk	0:03	0:04	0:04	0:06	0:06
save file to hard disk	0:10	0:12	0:12	0:19	0:17

One of the most pleasant features of Omninet is its mass storage tape back-up, called the Bank. Tapes are available in 100- or 200-megabyte capacities, and the software provides elegant and flexible options for saving and restoring disk images and volumes. Additionally, an entire drive can be copied to a second drive, or a tape transferred to a second tape (assuming there is a second Bank on the network).

Performance

We tested OMNINET with six small benchmark programs designed to view network performance with a heavy I/O load (see table 2). The random-access test writes 50 records, within a 1,000-record file, to 50 other records. Each record is 50 bytes long. The sequential-read test reads 641 lines, each 50 bytes long, within a 40,000-byte file. The sequential read/write test reads and then writes 641 lines, each 50 bytes long, to another file.

The dBASE II benchmarks used 200 records, each containing fields for name, address, telephone number, and zip code. These records were sorted on one key, indexed on one key, and indexed on two keys. The word processor benchmarks were performed with WordStar and WordPerfect, in conjunction with a 30,000-byte file.

The programs were run under several different conditions, with the OMNINET hardware always *in situ*, except for the control tests in the standard single-user PC-DOS environment. The user-1 unit was an IBM PC with an expansion chassis, 512K, a 10-megabyte fixed disk, and an IBM Graphics printer. The user-2 machine was a PC with 256K memory, without a printer.

First the single-user tests were done on each unit, while the second computer was idle. Next, the tests were performed with both computers simultaneously running the benchmarks from different volumes on the disk server.

Under PC-DOS alone, the random access test took 6 seconds, the sequential read/write test took 29 seconds, and the sequential read test took 14 seconds. Performance in the single-user situation did not decline noticeably using the Omninet software. When two users performed these tests simultaneously, benchmarks that accessed the fixed disk showed some degradation, but in general, the degradation was neither excessive nor particularly noticeable. The Omninet software had a similarly mild effect on the dBASE II and word processor benchmarks.

Although the software is reasonably robust, it does have a few quirks that range from irritating to disastrous. Error checking on input is lackadaisical. Often the system will accept inaccurate information without warning the user that it will do so. When asked to remove a volume, the volume manager does not provide a warning message that files are still present in the volume.

Omninet has few, if any, provisions for fielding time-out errors. If a device is unavailable, the computer that is requesting transmission hangs. Corvus intends to fix this problem in another release.

Users might feel somewhat isolated within Omninet. There is no way to find out which devices are hooked to which host computers or to see who is on the network.

A more serious omission is the lack of any provision for dynamic disk, file, and record locking to prevent data corruption in a multi-user situation. All users are assumed to be friendly to the network, but there is no way, when accessing a file, to find out if someone else is currently using it. Corvus implements semaphores for these facilities, and they are available to application programmers who are writing multi-user software to run on Omninet. However, dynamic locking at several levels is now available on many local area networks that do not even require separate disk servers.

The Omninet protection scheme is primitive: two passwords, one for the system manager and one for the disk server, will get a user into the entire system. Privacy is available only at the volume level. Once a user has access to a volume, he or she has access to every subdirectory and file that is contained therein. There is no way to write-protect a single file or group of files within a volume. Again, several other networks offer more sophisticated privacy schemes. If privacy and disk-data corruption are important factors, purchasers of Omninet will have to look to application programs to provide these facilities.

The installation problems aside, Omninet is nicely designed and generally bug-free. The integration of utility servers and mass storage back-up provides a sense of unity to the network hardware and software environment. More significant, Omninet's transparency and speed are excellent. Revised documentation and well-implemented application software will augment what is already a sturdy product, capable of handling the network requirements of a small business office.

Omninet
Corvus Systems, Inc.
2100 Corvus Drive
San Jose, CA 95124
408-559-7000
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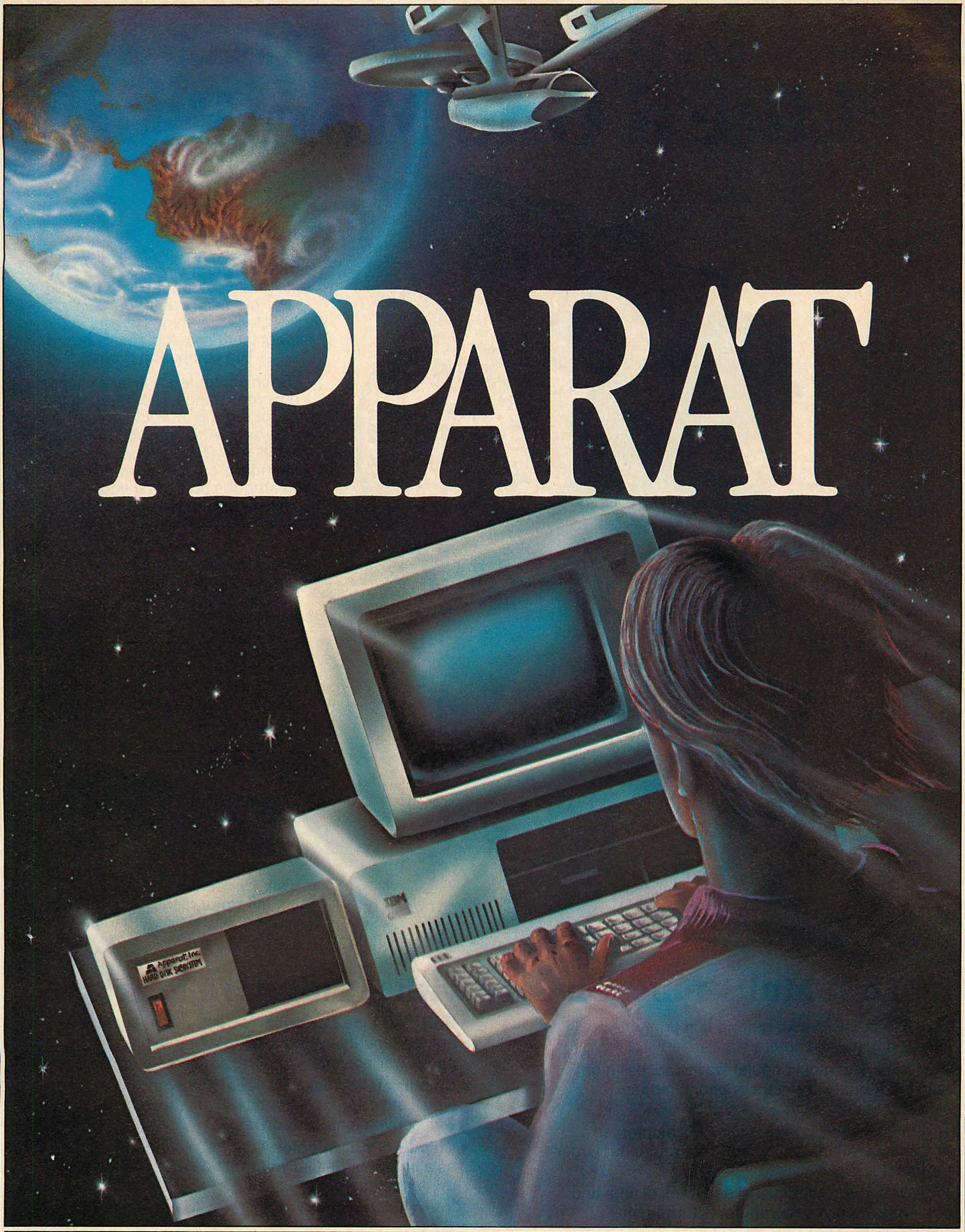

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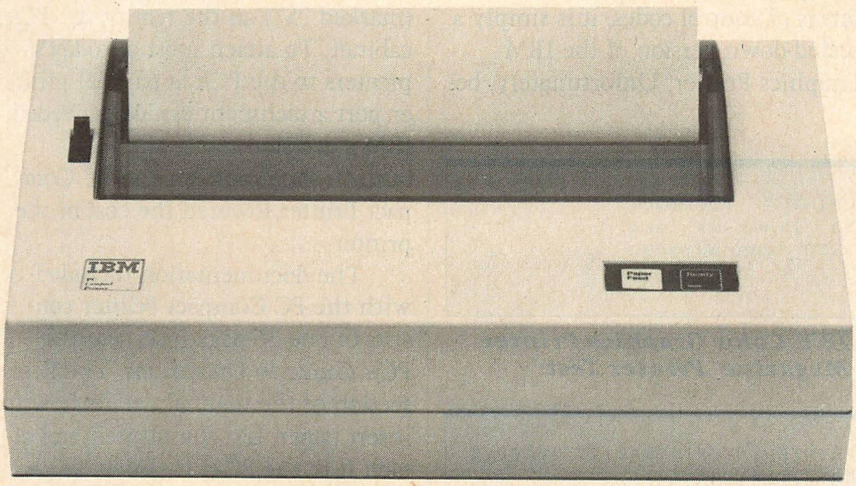

Photo 1: IBM's Compact Printer—a low-end, inexpensive printer for the PC*jr* owner

IBM has recently added two new printers to its line of personal computer products. The PC Compact Printer, for use with the PC*jr* only, prints on special thermal paper. The Color Graphics Printer, a monster of a machine (at 55 centimeters wide by 32 centimeters deep by 25 centimeters high), prints graphics and near-letter-quality text in color.

IBM's Color Graphics and Compact printers serve two very different segments of the PC marketplace.

PC Compact Printer

The PC Compact Printer is truly compact (31 centimeters wide by 19 centimeters deep by 9 centimeters high) and extremely simple in design (see photo 1). Only three controls are on the outside of the printer: a paper release lever, a paper feed button, and an on/off switch. A curved cover over the printing mechanism lifts to reveal a rack for roll paper. Because the printer has been designed specifically for the PC*jr*, there are no DIP switches to set or cables to build; installing the printer is simplicity itself.

The PC Compact Printer has three paper-feeding options: rolls of

paper, single sheets, and fanfold paper. Because it uses thermal printing technology, the PC Compact Printer can print only on specially treated, thermal paper. Although thermal printers are quiet, they also have their disadvantages. Text printed by thermal printers tends to be rather light immediately after printing, and it gradually fades away over time, especially when exposed to bright light. The poor print quality and the characteristic silver sheen of thermal paper result in a less-than-satisfactory printed product; the paper is also expensive.

In defense of IBM, it may be said that this printer was designed for low cost and the printing needs of the average PC*jr* user. Still, many PC*jr* owners undoubtedly will purchase slightly more expensive impact printers rather than tolerate the poor print quality of the PC Compact Printer.

Although most of the control codes used with the PC Compact Printer are carry-overs from previous IBM and Epson printers, many capabilities are lacking in the new printer. Although the Compact Printer can print double-width and compressed text, it does not have emphasized, double-strike, subscripted, or superscripted text, and it has only low-density graphics. In terms of control codes, it is simply a scaled-down version of the IBM Graphics Printer. Unfortunately, because of the lack of medium-density graphics, DOS 2.1's GRAPHICS.-COM graphic screen-dump utility does not work with the Compact.

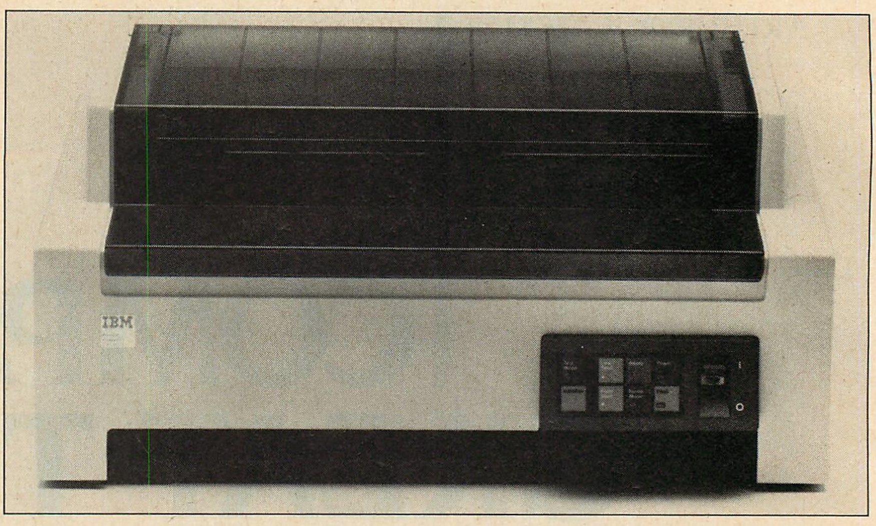

Photo 2: IBM's Color Graphics Printer—a monster of a printer for the business user

The PC Compact Printer has a built-in, three-wire cable that attaches to the serial connector (marked "S") on the rear of the PC*jr* cabinet. To attach most of today's printers to the PC*jr*, a parallel printer port attachment device is needed. IBM's decision to use the PC*jr*'s built-in serial port for the PC Compact Printer lowered the cost of the printer.

The documentation included with the PC Compact Printer consists of one 36-page insert for the *PC*jr *Guide to Operations.* The first section of the manual details how to insert paper, test the printer, and attach it to the PC*jr*. It also explains the shortcomings of thermal paper and suggests ways to delay the fading effect. Technical information in the manual includes a list of printer control codes and their functions, a list of legal print mode combinations, a chart of the characters that the PC Compact Printer can print (these include most of the PC character set but not the line-drawing characters), and a diagram of connections in the serial cable.

The PC Compact Printer is suited for the home environment in

```
Throughput report for IBM COLOR PRINTER  (DP MODE)
Elapsed time =  26  seconds for 50  lines of text.
 125  characters per second for 3250  characters.
 115.3846  Lines per minute.
```

Figure 1: A Sample Printed by the IBM Color Graphics Printer (DP Mode) Showing Results of* PC *Magazine Printer Test

```
Throughput report for IBM COLOR PRINTER (TEXT QUALITY 10 CPI)
Elapsed time =  42  seconds for 50  lines of text.
 77.38095  characters per second for 3250  characters.
 71.42858  Lines per minute.
```

Figure 2: A Sample of Text Printed by the IBM Color Graphics Printer (Text Quality Mode) Showing Results of* PC *Magazine Printer Test

```
Throughput report for IBM COLOR PRINTER
Elapsed time =  130  seconds for 50  lines of text.
 25  characters per second for 3250  characters.
 23.07692  Lines per minute.
```

Figure 3: A Sample of Text Printed by the IBM Color Graphics Printer (Near Letter Quality Mode) Showing Results of* PC *Magazine Printer Test

ABBREV	MEANING	DECIMAL CODE
BEL	Bell	7
BS	Backspace	8
CAN	Clear Buffer	24
CR	Carriage return	13
DEL	Delete character	127
ESC	Escape character	27
FF	Form feed	12
HT	Horizontal tab	9
LF	Line feed	10
NUL	Null character	0
VT	Vertical tab	11
{ }	Choice of possible values	
. .	Repeated	

Table 1: Abbreviation Key to Tables 2, 3, and 4

FUNCTION	ASCII CODE
BIT IMAGE GRAPHICS	
Double-speed, medium-density graphics	ESC Y length_word data. .
*Low-density graphics	ESC K length_word data. .
Medium-density graphics	ESC L length_word data. .
FORMAT CONTROL	
*Horizontal tab	HT
*Horizontal tab set	ESC D positions. . NUL
*Form feed	FF
*Set form length in lines	ESC C number_of_lines
Set form length in inches	ESC C NUL number_of_inches
*Vertical tab	VT
*Vertical tab set	ESC B positions. . NUL
LINE SPACING	
*Set line spacing to 1/8 inch (1/9 inch on IBM Compact Printer)	ESC 0
*Set line spacing to 7/72 inch (1/12 inch on IBM Color Printer, 1/9 inch on IBM Compact Printer)	ESC 1
*Set line spacing to 1/6 inch	ESC 2
MISCELLANEOUS	
Bell	BEL
*Carriage return	CR
*Null	NUL
*Print left-to-right for one line	ESC <
Unidirectional print start/end	ESC U {0, 1}
PAPER FEED EXECUTION	
*Line feed	LF
*Perforation-skip mode cancel	ESC 0
*Perforation-skip mode set	ESC N number_of_lines
PRINT MODES	
*Compressed mode cancel	DC2
*Compressed mode set	SI
Double-strike mode cancel	ESC H
Double-strike mode set	ESC G
Emphasized mode cancel	ESC F
Emphasized mode set	ESC E
*Enlarged mode cancel	DC4
*Enlarged mode set/cancel	ESC W {0, 1}
*Enlarged mode set	S0
Superscript/subscript mode cancel	ESC T
Superscript/subscript mode set	ESC S {0, 1}
*Underlined mode set/cancel	ESC - {0, 1}

**compatible with IBM Compact Printer*

Table 2: Functions Common to Epson FX-80, IBM Graphics, and IBM Color Printers

that it is easy to use and inexpensive. If the problems inherent to thermal printing are ignored, it is an attractive printer.

Color Graphics Printer

The IBM Color Graphics Printer was designed with performance, not cost-consciousness, in mind. It is a rugged machine; its case is made with surprisingly strong (6-millimeter-thick) plastic, and the entire print mechanism is built on a sturdy metal frame (see photo 2). The print-head-positioning motor is large (9 centimeters in diameter,

compared to 3.5 centimeters for the motor on the Epson FX-80). In short, the IBM Color Graphics Printer is built like a tank.

On the front of the printer is a group of buttons for manual control of printer functions, including line feed, form feed, top-of-page set, printer test, and power on/off. Below this is a slot for inserting single sheets of paper into the printer; continuous-form paper is fed through a slot located underneath the printer. The Color Graphics Printer can handle standard and wide (up to 30.5-centimeter) forms with its fully adjustable tractors.

On the inside front wall of the printer are the DIP switches, which control character set, line spacing, perforation-skip mode, automatic line-feed mode, line width, page length, print quality, and other functions. They can be reached by simply raising the access cover. A fuse, located on the rear panel of the printer, is as easily accessible as the DIP switches.

By far the most interesting feature of the Color Graphics Printer is its ability to print text and graphics in red, blue, yellow, black, and any combination thereof. This capability is achieved through the use of a multicolored ribbon and a mechanism that controls which part of the ribbon is in front of the print head at any time. Although no software is included with the printer to test its color graphics, its use of standard Epson bit image graphics control codes makes custom programming quite easy to do. However, a simple screen-print utility would have been a welcome (and impressive) addition to the standard features of the Color Graphics Printer. Alas.

Another impressive feature of this printer is its print quality. The printer will produce text comparable to that of the Epson FX-80 at 200 characters per second (see figure 1), and by sending a control code (or setting one of the DIP switches), two other print-quality levels can be

FUNCTION	EPSON FX-80	IBM GRAPHICS	IBM COLOR
BIT IMAGE GRAPHICS			
8-pin graphics	ESC * graphics_mode (0-6) length_word data.		
9-pin graphics	ESC ° {0, 1} length_word data.		
High-density graphics	ESC Z length_word data.		ESC Z length_word data.
DOWNLOADABLE CHARACTER SET CONTROL			
Copy ROM fonts to download area	ESC : NUL NUL NUL		
Define download character generator	ESC & NUL data.		
Select internal/download generator	ESC & {0, 1} NUL		
FORMAT CONTROL			
Automatic right justify			ESC M {0, 1}
Backspace	BS		BS
*Clear tabs			ESC R
Column width set	ESC Q number_of_characters		
Left margin set	ESC 1 number_of_spaces		
Margin set			ESC X left_margin right_margin
Set line spacing to n/72 inch 0 <= n <=85	ESC A n	ESC A n	ESC A n ESC 2
Set line spacing to n/144 inch			ESC 3 n
Set line spacing to n/216 inch	ESC 3 n	ESC 3 n	
Top of page set			ESC 4
Variable forward space n/120 inch			ESC d n (2 bytes)
Variable reverse space			ESC e n (2 bytes)
VFU channel select	ESC / channel (0-7)		
VFU position set	ESC b channel (0-7) positions. . NUL		
INPUT DATA CONTROL			
Bit 7 = one	ESC >		
Bit 7 = zero	ESC =		
Bit 7 control cancel	ESC #		
*Clear buffer	CAN	CAN	CAN
Clear last byte in buffer	DEL		
Control code character set select	ESC 7	ESC 7	
Print characters above 128	ESC 6	ESC 6	
Print characters below 32			ESC \ number_of_chars (2 bytes)
Print a character below 32			ESC °
Printer deselect	DC3		DC3 ESC Q 2
Printer select	DC1		DC1
Undefined area as control/printable	ESC I {0, 1}		
MISCELLANEOUS			
Aspect ratio set (0 = 5:6, 1 = 1:1)			ESC n {0, 1}
Automatic ribbon hand shift			ESC a
Control value data type select			ESC @ {0, 1}
Half-speed printing cancel/select	ESC s {0,1}		
Immediates print cancel/select	ESC i {0, 1}		
Initialize printer	ESC @		
Initialize signal function set			ESC ? {0, 1}
International character set select	ESC R character_set (0-8)		
Ribbon band 1 select			ESC y
Ribbon band 2 select			ESC m
Ribbon band 3 select			ESC c
Ribbon band 4 select			ESC b
PAPER FEED EXECUTION			
Forward feed n/144 inch			ESC J n
Forward feed n/216 inch	ESC J n_	ESC J n_	
Reverse feed n/216 inch	ESC j n_	ESC j n_	
Reverse feed one line			ESC]
PRINT MODES			
Character set 1 select			ESC 7
Character set 2 select			ESC 6
Compressed mode select	ESC SI		ESC SI
Elite mode select	ESC M		ESC :
Elite mode deselect	ESC P		
Enlarged mode select	ESC SO		ESC SO
Italic mode deselect	ESC 5		
Italic mode select	ESC 4		
Print mode select	ESC ! print_mode (0-63)		
Printing quality select			ESC I print_quality (1-3)
Proportional spacing set/cancel	ESC p {0, 1}		ESC P {0, 1}

**compatible with IBM Compact Printer*

Table 3: Functions Differing among Epson FX-80, IBM Graphics, and IBM Color Printers

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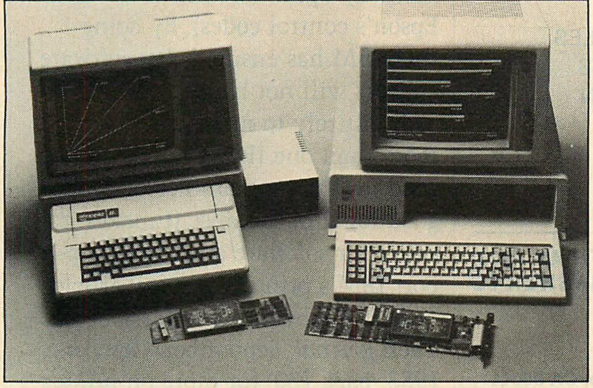

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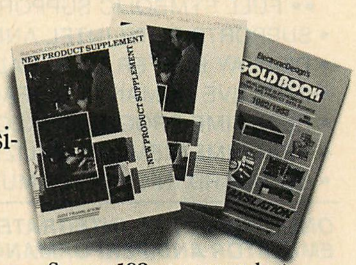

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chosen. The Text Quality mode (figure 2) produces print only slightly better than the Epson; the Near Letter Quality mode (figure 3) produces text almost indistinguishable from that of a typewriter. In this mode, the print head makes two passes over every line. This slows the printer considerably, but the results are well worth the wait. The printer also has a proportional print mode that can be used in conjunction with any of the print modes.

The documentation included with the Color Graphics Printer is 149 pages long, designed to be inserted in the *Guide to Operations*. It is complete, well-written, and includes detailed information on every aspect of the printer. The installation and operation sections have many clear illustrations. Complete technical information, including a list of the printer control codes and their functions, a chart explaining DIP switch settings, and a complete list of all printable characters (the Color Graphics Printer can print every symbol in the PC character set), is provided. A quick reference card would be a handy addition to the documentation, considering the complexity and flexibility of the control code set.

The Color Graphics Printer is supplied with a diagnostics package identical to that included in the *Guide to Operations* except that it has been updated to test the Color Graphics Printer, as well as the IBM Matrix and IBM Graphics printers. A complete replacement for the Problem Determination Procedures section of the *Guide to Operations* is supplied with this software. Unfortunately, the program tests only the printer's ability to print text, not graphics, in multiple colors.

COMPATIBILITY WITH OTHER EPSON AND IBM PRINTERS

Control code compatibility is a major issue in designing printers. IBM has chosen to maintain as much compatibility as possible with its earlier printers (which were made by Epson and therefore used Epson's control codes). By doing this, IBM has ensured that software authors will not have to rewrite code entirely to make it work on more than one IBM printer. This is good for the programmer; it is also good for IBM, because it makes it easier for software authors to support IBM's printers (see my article, "Epson Technical Comparison," *PC Tech Journal*, September/October 1983, page 130, for more on printer compatibility issues).

Table 1 lists all control codes that can be used without modification on the Epson FX-80, the IBM Graphics, and the IBM Color Graphics printers. Functions that

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CIRCLE NO. 145 ON READER SERVICE CARD

FUNCTION	ASCII CODE
BIT IMAGE GRAPHICS	
*Low-density graphics	ESC K length_word data.
FORMAT CONTROL	
Clear tabs	ESC R
*Form feed	FF
*Horizontal tab	HT
*Horizontal tab set	ESC D positions. . NUL
*Set form length in lines	ESC C number_of_lines
*Vertical tab	VT
*Vertical tab set	ESC B positions. . NUL
INPUT DATA CONTROL	
*Clear buffer	CAN
LINE SPACING	
*Set line spacing to 1/9 inch (1/8 inch on other printers)	ESC 0
*Set line spacing to 1/9 inch (1/12 inch on Color; 7/72 on others)	ESC 1
*Set line spacing to 1/6 inch	ESC 2
MISCELLANEOUS	
*Carriage return	CR
*Null	NUL
*Print left-to-right for one line	ESC <
PAPER FEED EXECUTION	
*Line feed	LF
*Perforation-skip mode cancel	ESC 0
*Perforation-skip mode set	ESC N number_of_lines
Set automatic linefeed mode	ESC 5
PRINT MODES	
*Compressed mode cancel	DC2
*Compressed mode set	SI
*Enlarged mode cancel	DC4
*Enlarged mode set/cancel	ESC W {0, 1}
*Enlarged mode set	SO
*Underlined mode set/cancel	ESC - {0, 1}

**compatible with Epson FX-80, IBM Graphics, and IBM Color printers*

Table 4: Functions Available in the IBM Compact Printer

will also work on the PC Compact Printer are clearly marked. Table 2 lists functions that cannot be used on all three printers; table 3 lists the subset of functions available on the PC Compact Printer. All but two of these codes are compatible with the Epson FX-80, IBM Graphics, and IBM Color Graphics printers.

The Color Graphics Printer has all the major features of the Epson FX-80 save one: character sets that can be downloaded. Except for this, the Color Graphics Printer builds upon the functions of other printers, with new codes to control ribbon bands and print quality.

The control-code set of the PC Compact Printer, on the other hand, is a stripped-down version of that used in earlier Epson and IBM printers. The PC Compact Printer can handle all of the important text-handling functions of other printers and has low-density graphics as well, but its repertoire does not extend far beyond this.

TWO MARKETS ADDRESSED

Both the PC Compact Printer and the Color Graphics Printer address a specific part of the printer marketplace. The PC Compact printer is designed for home use, and is therefore less expensive and less capable than other printers. The Color Graphics Printer, on the other hand, is designed with quality (and color graphics) in mind, and is best suited for business and professional use. IBM has attempted to maintain control-code compatibility with its other printers, and although it sacrificed some with the PC Compact, it has been largely successful.

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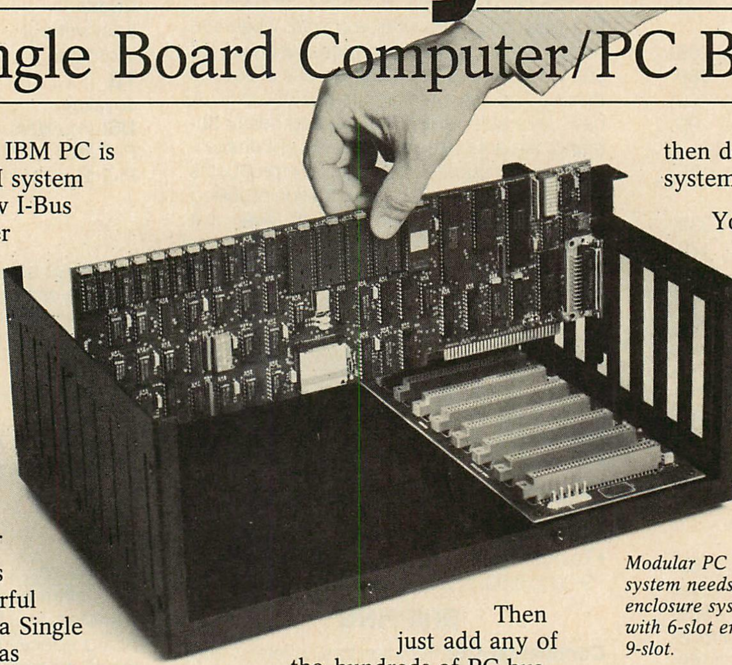

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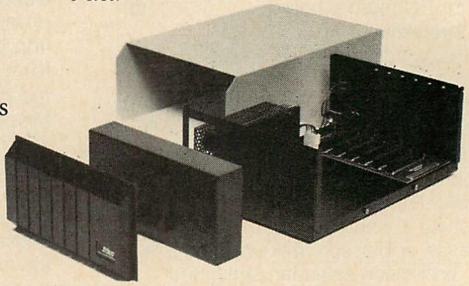

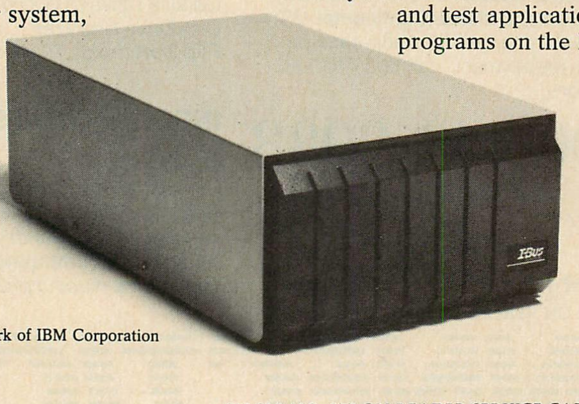

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CIRCLE NO. 277 ON READER SERVICE CARD

The DOS COMMAND IBM FORGOT

EPSON.COM simplifies printer initialization

DOUGLAS RITARI

Users of the IBM PC are blessed by having access to the variety of sophisticated printing features offered by the new intelligent dot-matrix printers. Many different print fonts and densities are available. Few of the printers offer an easy method of switching to these different control modes, however; consequently, many of the optional fonts that are available are used only infrequently.

The most common way of initializing a computer printer is through the use of the BASIC/BASICA language on the PC. These programs take up considerable space on a diskette (15,000 to 25,000 characters—especially if they are put only on diskettes) and are not easy for an inexperienced person to use. Clearly a better solution is needed.

One such solution is provided by EPSON.COM, a small, efficient utility program that, in addition to being easy to use, is only 281 characters long (see listing 1). The program was designed around the Epson MX-80 command protocol, because of the Epson's widespread popularity and near-compatibility with the IBM graphics printer. It will work with any printer, however, because of a hexadecimal input mode that allows any set-up character sequence to be sent to any printer. See table 1 for a summary of the segments, groups, and symbols used in the EPSON.COM program.

Douglas Ritari is an information resource manager for St. Paul Fire and Marine Insurance Company in St. Paul. He functions as a systems analyst who specializes in microcomputers and office automation.

Program Operation

The simplest way to activate the program is to type "EPSON." When no optional parameters are entered, the printer is set for the double-strike and emphasized-print font. In my opinion, this font produces the best near-letter-quality print that Epson-compatible printers can produce. Optional parameters that may be entered (by typing EPSON E T, for example) are

- **E**—Emphasized printing (characters are thicker than usual)
- **D**—Double-strike printing (each character is printed twice in the same place)
- **I**—Italics
- **W**—Wide-character printing (5 char/inch)
- **C**—Compressed-character printing (17.16 char/inch)
- **T**—Top-of-form command (advances the paper to the top of the next logical page on almost all printers)
- **R**—Resets the printer to its power-up state (resets logical top-of-page; eliminates the need to turn the printer off and on to reset)
- **U**—Unidirectional printing (the print head prints only from left to right, instead of in both directions; (although slower, this produces the best appearance)
- **/xx/**—Hexadecimal input mode ("xx" represents paired hexadecimal numbers that are sent directly to the printer as is, no spaces allowed)

All other characters are ignored; spaces between parameters are optional (except in the hexadecimal mode) with upper- and lower-case letters being permissible. The Epson can understand a greater number of commands than this, but the list includes most of the common ones.

Creating the Program

This program is intended to be assembled and run as a "COM" file using any PC-compatible assembler. COM programs are designed to run within one segment and do not include a stack segment. Because there is no stack segment, a warning message will be generated by the linker when the program is run; don't be concerned about the message, as this is normal when a COM program is generated.

After linking the program using the DOS LINK command, name it EPSON.EXE. Now run the IBM EXE2BIN command, which converts appropriately prepared .EXE files to .COM format. After EXE2BIN has been run, the disk directory will contain a file named EPSON.BIN. Simply rename this file to EPSON.COM.

When no optional parameters are entered, the printer is set for the double-strike and emphasized-print font. In my opinion, this font produces the best near-letter-quality print that Epson-compatible printers can produce.

The .COM format, rather than the .EXE format, was used to reduce the program's size. The original version, which was an .EXE file, was over 1000 characters long.

How It Works

The general logic of the program follows these steps:

1. Save the contents of the DS register onto the stack to return control to DOS when the program completes (lines 34-37).
2. Set up the Indexing registers DI and SI for movement of the parameters entered from the Program Segment Prefix (PSP), which is located at offset 80H (lines 41-45).
3. Check the character count of the parms that were entered. If the count equals zero, no parms were entered. Jump to the default routine and send the printer the control codes for double strike/emphasized print (lines 49-53).
4. If the program has reached the SEAR procedure, parms were entered (or perhaps an extra space character was entered after the EPSON command). Examine the parm character and see if it was entered as a lower-case letter. If so, reduce its value by 32 to convert it to upper-case. Now begin comparing this parm character to the program options. If it is a "/" character, toggle the hexadecimal switch to send all valid hex characters directly to the printer until another "/" is found. If the parm is an E-D-C-T-R-I-U-W, jump to the appropriate routine to process this code. This routine continues until the count of parm characters reaches zero. The program then jumps to PGMEND and ends (lines 65-88).
5. The PGMEND (program end) procedure will sound the printer's bell if unpaired hexadecimal parms were entered. It also tests to see if anything was printed during the program. If not, the DEFAULT routine sends emphasize/double strike. Then a return command is executed to return control to DOS (lines 152-172).
6. The PASTHRU routine (lines 99-108) is used in conjunction with the HEXMATH subroutine (lines 199-210) to convert and process parms into hexadecimal numbers.
7. The ESCAPE subroutine is used to send the escape character 1bH to the printer. Most of the predefined codes are initiated by sending first the escape character and then the appropriate one or two digits to do the print mode setup (lines 176-183).
8. The PRINTER subroutine is the only routine in the program

that actually sends codes to the printer. When control passes to PRINTER, all the work has been done; the character to be printed is already in the AL register. The DOS interrupt 17H is then called to process the print request. Note: there is no check to see if the routine actually worked. However, if the printer is off-line, no message to confuse inexperienced users will be generated. The program will not crash the system (lines 189-195).

9. Finally, the PARM_E through PARM_W routines (lines 112-146) process the predefined Epson parms into appropriate control codes. Note that the control codes are "hard-wired" into these routines instead of being placed in a common data area. Again, this was done to save space and to cut down the program size; it is not difficult to change if the user wants to custom configure this program for another printer.

USING THE PROGRAM

Use of the EPSON command is fairly straightforward if consideration is given to a few idiosyncrasies of the Epson printer and to the housekeeping activities of certain programs. First, be aware that certain printing modes are incompatible with one another—for example, trying to use emphasized and compressed type simultaneously with an Epson printer will result in emphasized font only. The EPSON.COM program cannot help out here, as the printer has the final say on what it will and will not accept.

If in doubt as to which print mode is currently operational, do a reset (parm R) before issuing new control codes. Consult the owner's manual for these and other precautions if problems are encountered.

Another problem that might be encountered with certain programs—VisiCalc, for example—is that when the user goes to the

```
Segments and groups:

                N a m e              Size   align  combine class

MAIN . . . . . . . . . . . . . .     0219   PARA   PUBLIC  'CODE'

Symbols:

                N a m e              Type    Value  Attr.

BELEND . . . . . . . . . . . . .     L NEAR  01BC   MAIN
DEFAULT. . . . . . . . . . . . .     L NEAR  01D5   MAIN
DIGITS . . . . . . . . . . . . .     L BYTE  0106   MAIN
ESCAPE . . . . . . . . . . . . .     N PROC  01E1   MAIN    Length =000B
HEX. . . . . . . . . . . . . . .     L BYTE  0107   MAIN
HEXMATH. . . . . . . . . . . . .     N PROC  01F9   MAIN    Length =0020
MATH2. . . . . . . . . . . . . .     L NEAR  020C   MAIN
PARM . . . . . . . . . . . . . .     L BYTE  0108   MAIN
PARM_C . . . . . . . . . . . . .     L NEAR  0188   MAIN
PARM_D . . . . . . . . . . . . .     L NEAR  0181   MAIN
PARM_E . . . . . . . . . . . . .     L NEAR  017A   MAIN
PARM_I . . . . . . . . . . . . .     L NEAR  019D   MAIN
PARM_R . . . . . . . . . . . . .     L NEAR  0196   MAIN
PARM_T . . . . . . . . . . . . .     L NEAR  018F   MAIN
PARM_U . . . . . . . . . . . . .     L NEAR  01A4   MAIN
PARM_W . . . . . . . . . . . . .     L NEAR  01B0   MAIN
PASTHR2. . . . . . . . . . . . .     L NEAR  0175   MAIN
PASTHRU. . . . . . . . . . . . .     L NEAR  0165   MAIN
PGMEND . . . . . . . . . . . . .     L NEAR  01C6   MAIN
PRINTER. . . . . . . . . . . . .     N PROC  01EC   MAIN    Length =000D
SEAR . . . . . . . . . . . . . .     L NEAR  0124   MAIN
SEARBK . . . . . . . . . . . . .     L NEAR  015A   MAIN
SEARCP . . . . . . . . . . . . .     L NEAR  012E   MAIN
SEAREN . . . . . . . . . . . . .     L NEAR  015C   MAIN
SIXTEEN. . . . . . . . . . . . .     L BYTE  0104   MAIN
SSTART . . . . . . . . . . . . .     L NEAR  0109   MAIN
START. . . . . . . . . . . . . .     F PROC  0100   MAIN    Length =00E1
SWITCH . . . . . . . . . . . . .     L BYTE  0103   MAIN
TESTPR . . . . . . . . . . . . .     L BYTE  0105   MAIN
TOGGLE . . . . . . . . . . . . .     L NEAR  015F   MAIN

Warning Severe
Errors  Errors
0       0

TIME==> 19:26:29.96
```

Table 1: Segments, Groups, and Symbols Used in EPSON.COM

menu option to print something, the program resets the printer. This effectively wipes out any control codes that may have previously been established. Again, the EPSON command will not help in this case.

EXAMPLES

Word processing can serve as an example of the use of EPSON.COM. Assume that a user wants to produce a document in italics. He's also a little concerned about producing a

good, solidly black type font, because his ribbon is getting old and worn. Therefore, using the parameters that produce double-strike and italics, he enters

EPSON ID (producing italic/double-strike)

Or perhaps the user wants to advance the paper to the top of the page and enter the WIDE print mode for a memo for the office bulletin board. He types in

EPSON t r w (producing Top-of-form/Reset, just to be safe/Wide)

Note that the spaces between the parameters and the lower-case letters did not affect the program.

Finally, let's imagine that a user decides to single-sheet feed the printer, but the "paper out" sensor keeps disabling the printer as he gets halfway down the page. The command to disable the paper-out sensor is not one of the *predefined* parms; however, the hexadecimal input option will still save the day. The Epson manual says that the (escape) sequence followed by an "8" will disable the paper-out sensor. This translates into 1b38 in hexadecimal numbers. Therefore, the user should type in

EPSON/1B38/

and the paper-out sensor will be disabled until the printer is turned off or reset. Note that no spaces are allowed between the slashes and that only valid hex numbers 0–9 and A–F are allowed. (Epson-compatible printers will BEEP at you if unpaired or illegal numbers are entered). However, additional parameters may be entered before or after the slashes to advance the paper or set any predefined character font.

To further simplify the process of entering hexadecimal characters (it's hard to remember many hex numbers), create a one-line batch file that will do the work for you. For example, a batch file entitled "DISABLE.BAT" could contain the preceding command and could be executed simply by typing "DISABLE." Also, the AUTOEXEC.BAT file could contain the appropriate commands to automatically initialize the printer upon startup.

Conclusion

The EPSON DOS command has been of great help to me and to other PC users over the past six months, both on Epsons and on a variety of other printers that are used in the office. With imagination and the printer manual, the possible uses for this program are nearly unlimited. Who knows, maybe it will even do graphics.

Listing 1 EPSON.COM

```
NAME EPSON
PAGE 55,132
TITLE EPSON.COM - DOUGLAS RITARI - 12/6/83
;*********************************************************************
;  EPSON.COM   - Version 1.0 - Setup Utility for Epson Printer
;  by:  Douglas Ritari
;  DATE:  December 6, 1983
;*********************************************************************
;
MAIN    SEGMENT PARA PUBLIC 'CODE'
        ORG     100H
START   PROC    FAR
;
        ASSUME  CS:MAIN
        ASSUME  DS:MAIN
        ASSUME  SS:MAIN
        ASSUME  ES:MAIN
;
        JMP     SSTART  ;JUMP TO REAL START OF PROGRAM
;
;************ INITIALIZE DATA VARIABLES *****************************
;
SWITCH  DB      0       ;SWITCH FOR HEX '/' SEQ.- EITHER '0' OR 'FFH'
SIXTEEN DB      16      ;THE NUMBER '16' USED IN HEX CONVERSION - MUL.
TESTPR  DB      0       ;SWITCH TO TEST IF ANY OUTPUT WAS PRODUCED
DIGITS  DB      0       ;NUM. OF HEX DIGITS PROCESSED - '0' OR '1'
HEX     DB      0       ;HEXADECIMAL ACCUMULATOR
PARM    DB      0       ;MOVE PARAMETER TO HERE - 1 BYTE AT A TIME
;
;*********************************************************************
;  BEGIN PROGRAM - SAVE RETURN ADDRESS TO DOS
;*********************************************************************
;
SSTART:
        PUSH    DS      ;SAVE PSP SEGMENT ADDRESS
        MOV     AX,0
        PUSH    AX      ;SAVE RETURN ADDRESS OFFSET (PSP + 0)
```

```
;
;************** MOVE COUNT OF CHARACTERS INTO PARM AREA *************
;
        MOV     SI,80H  ;SOURCE STRING OFFSET (WITHIN PSP)
        MOV     DI,OFFSET PARM ;DEST. STRING OFFSET
        CLD             ;SET 'FORWARD' STRING OPERATIONS
        MOVSB           ;MOVE # OF PARMS ENTERED INTO 'PARM' VARIABLE
        DEC     DI
;
;*********** SET UP PARM FIELD'S POINTERS ***************************
;
        MOV     AL,PARM ;PUT NUMBER OF CHAR. IN PARM IN AL REGISTER
        MOV     CX,AX   ;PUT NUMBER OF CHAR. IN PARM IN CX REGISTER
        MOV     BX,OFFSET PARM  ;POINT TO PARMS BASE ADDRESS
        CMP     CX,0    ;WERE 'NO' PARMS ENTERED ?
        JE      SEAREN  ;SEND DEFAULTS - NO PARMS - END PROGRAM

;*********************************************************************
;  PARM(S) WERE ENTERED - SEARCH FOR AND PROCESS PARMAMETERS
;*********************************************************************
;
SEAR:   MOVSB           ;READ IN PARM FROM PROG. SEGMENT PREFIX
        DEC     DI
        MOV     AL,[BX] ;MOVE NEXT PARM TO INPUT REGISTER
        CMP     AL,96   ;96 IS THE SMALL LETTER 'A'
        JL      SEARCP  ;DO 'NOT' MODIFY THIS LETTER IF LOWER THAN 'a'
        AND     AL,223  ;REDUCE BY 32 - UNCAPS===> CAPS
SEARCP: CMP     AL,'/'  ;HEX SEQUENCE BEGUN OR TERMINATED
        JE      TOGGLE  ;TURN ESCAPE SEQUENCE FLAG ON OR OFF
        MOV     AH,0    ;CLEAR AH REGISTER
        CMP     AH,SWITCH       ;IS HEX SEQUENCE OFF ?
        JNE     PASTHRU ;PRINT CHAR.'S HEX VALUE IF HEX SWITCH IS ON
        CMP     AL,'E'  ;PARM TO 'EMPHASIZE' ?
        JE      PARM_E  ;PARM-E ROUTINE
        CMP     AL,'D'  ;PARM TO 'DOUBLE-STRIKE' ?
        JE      PARM_D  ;JUMP TO PARM-D ROUTINE
        CMP     AL,'C'  ;PARM TO 'COMPRESS' ?
        JE      PARM_C  ;JUMP TO COMPRESS ROUTINE
        CMP     AL,'T'  ;PARM TO 'GOTO TOP-OF-FORM' ?
```

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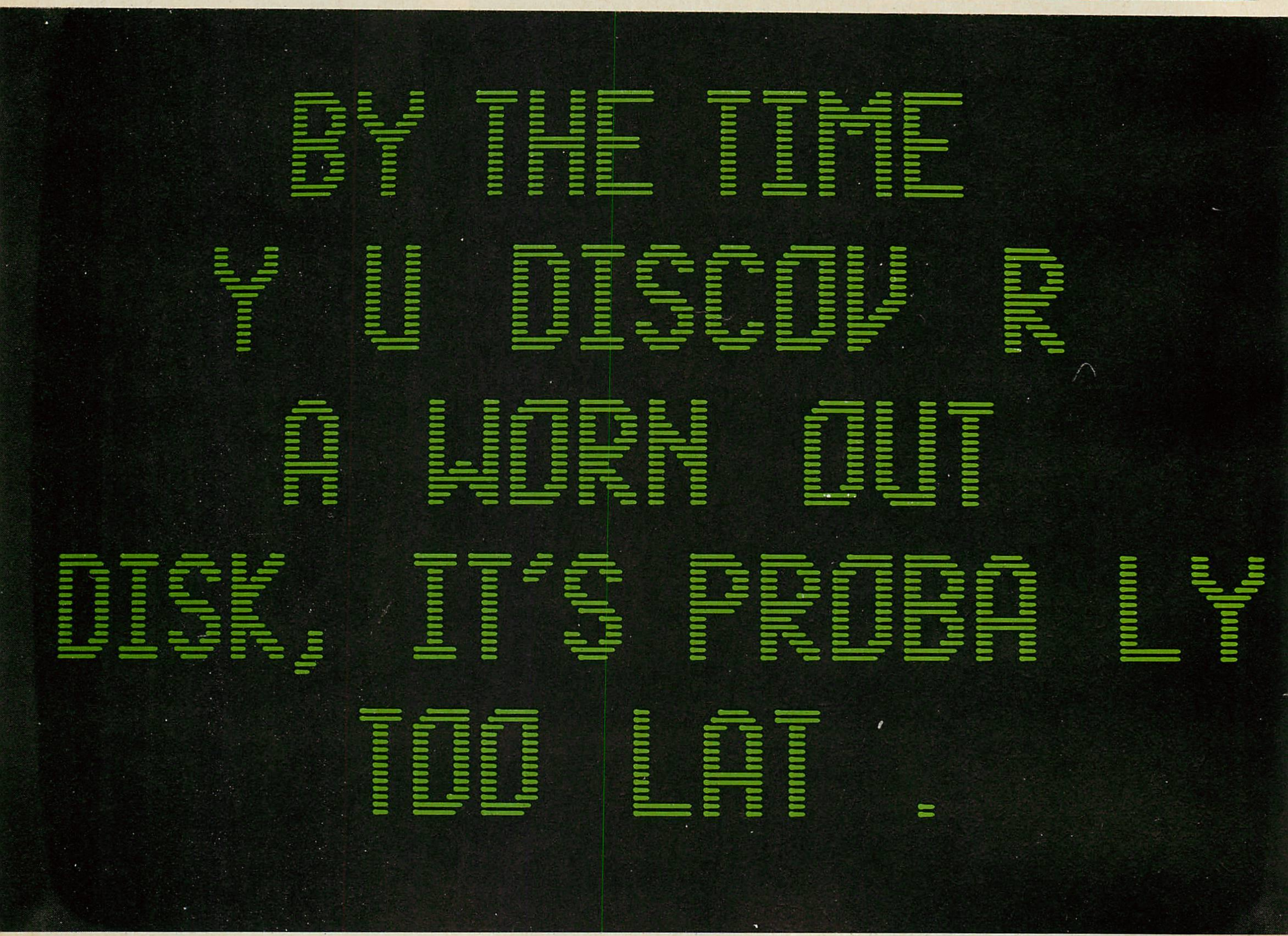
```
        JE      PARM_T  ;JUMP TO TOP-OF-FORM ROUTINE
        CMP     AL,'R'  ;PARM TO 'REINITIALIZE PRINTER' ?
        JE      PARM_R  ;JUMP TO RESET ROUTINE
        CMP     AL,'I'  ;PARM TO SET 'ITALIC' CHAR. ?
        JE      PARM_I  ;JUMP TO ITALICS ROUTINE
        CMP     AL,'U'  ;PARM TO SET 'UNI-DIRECTIONAL' PRINT MODE ?
        JE      PARM_U  ;JUMP TO 'UNI-DIRECTIONAL' ROUTINE
        CMP     AL,'W'  ;PARM TO SET 'WIDE' PRINT MODE ?
        JE      PARM_W  ;JUMP TO WIDE ROUTINE
SEARBK: LOOP    SEAR    ;LOOP BACK FOR OTHER PARMS
;
SEAREN: JMP     PGMEND  ;JUMP END-PROGRAM PROCEDURE
;
;********* BACKSLASH TOGGLES HEXIDECIMAL INPUT MODE ON/OFF ************
;
;  TOGGLE THE HEXADECIMAL INPUT PROC.-OFF===>ON  - OR  ON===>OFF
;
TOGGLE: NOT     SWITCH
        JMP     SEARBK  ;RETURN TO PARM SEARCH PROCEDURE
;
;********** EDIT FOR VALID HEXIDECIMAL NUMBERS ************************
;
PASTHRU: SUB    AL,30H  ;CONVERT FROM ASCII REPRES. TO REAL NUMBERS
        JC      BELEND  ;END PROGRAM IF WRONG PARM - SOUND BELL
        CMP     AL,9    ;CHECK FOR DIGIT > 9
        JBE     PASTHR2 ;VALID NUMBER - JUMP TO MATH ROUTINE CALL
        SUB     AL,7    ;CONVERT FROM ASCII REPRES. TO HEX DIGITS A-F
        JC      BELEND  ;END PROGRAM IF WRONG PARM - SOUND BELL
        CMP     AL,0FH  ;CHECK FOR DIGIT > '15' HEX
        JA      BELEND  ;END PROGRAM IF WRONG PARM - SOUND BELL
PASTHR2: CALL   HEXMATH ;CONVERT INPUT PARM TO HEX-NUMBER
        JMP     SEARBK  ;RETURN FOR NEXT PARM
;
;******** PRE-DEFINED EPSON PRINTER PARMS PROCEDURE *******************
;
PARM_E: MOV     AL,45H  ;CODE FOR 'EMPHASIZED' FONT
        CALL    ESCAPE
        JMP     SEARBK
```

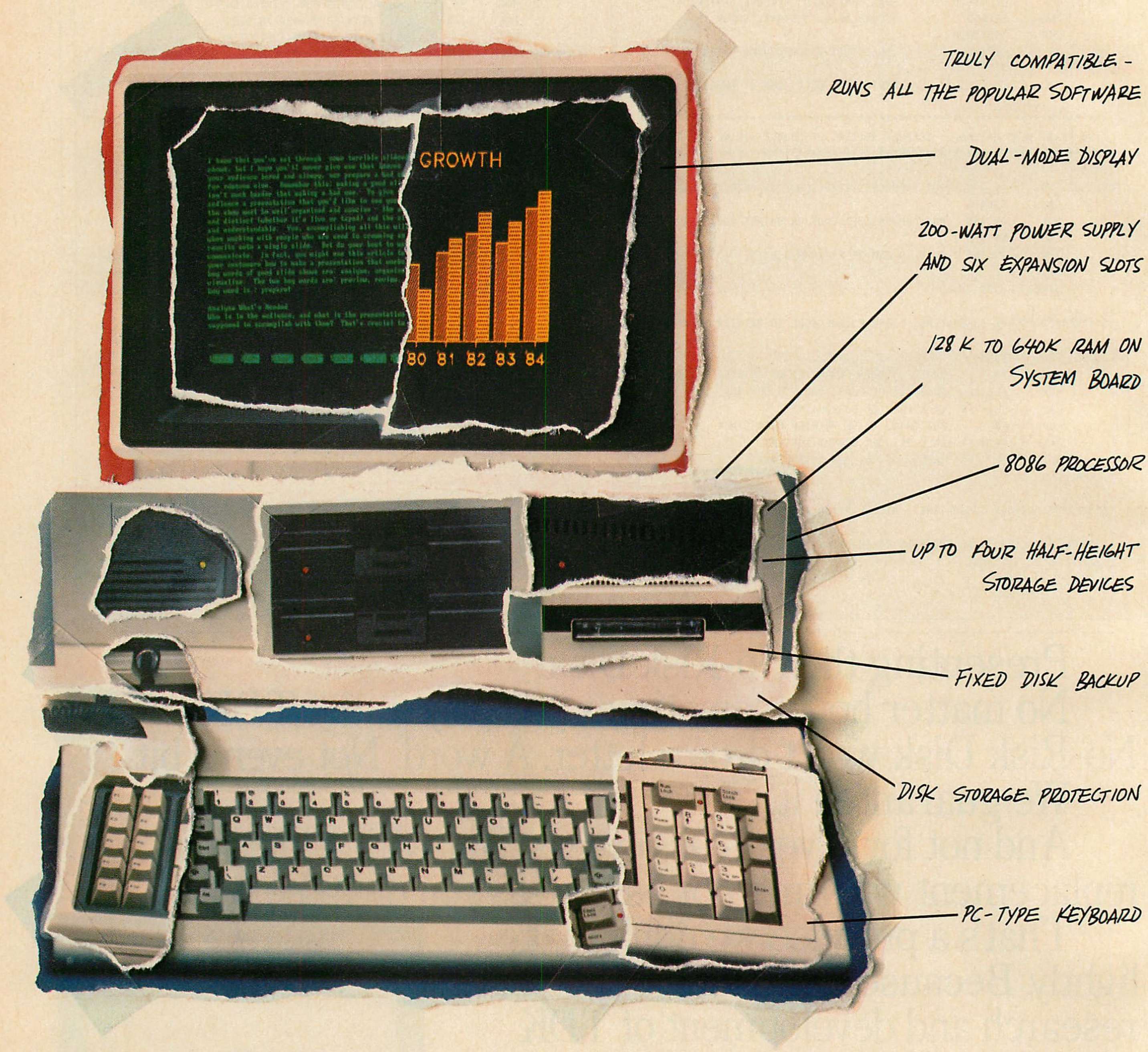
```
;
PARM_D: MOV     AL,47H  ;CODE FOR 'DOUBLE-STRIKE' MODE
        CALL    ESCAPE
        JMP     SEARBK
;
PARM_C: MOV     AL,0FH  ;CODE FOR 'COMPRESSED' FONT
        CALL    PRINTER ;COMPRESSED MODE DOES 'NOT' NEED PRE-ESCAPE SEQ
        JMP     SEARBK
;
PARM_T: MOV     AL,0CH  ;CODE TO 'ADVANCE PAPER TO TOP-OF-FORM'
        CALL    PRINTER ;FORM-FEED TO TOP-OF-FORM DOESN'T NEED ESC.
        JMP     SEARBK
;
PARM_R: MOV     AL,40H  ;CANCEL ALL MODES/RESET LOGICAL TOP-OF-FORM
                CALL    ESCAPE
        JMP     SEARBK
;
PARM_I: MOV     AL,34H  ;CODE FOR 'ITALICS' FONT
        CALL    ESCAPE
        JMP     SEARBK
;
PARM_U: MOV     AL,55H  ;TURN ON UNI-DIRECTIONAL PRINT MODE
        CALL    ESCAPE
        MOV     AL,1    ;CODE TO SET UNI-DIRECTIONAL 'ON'
        CALL    PRINTER
        JMP     SEARBK
;
PARM_W: MOV     AL,57H  ;CODE FOR 'PERMANENT DOUBLE-WIDE' FONT
        CALL    ESCAPE
        MOV     AL,1    ;CODE TO SET WIDE 'ON'
        CALL    PRINTER
        JMP     SEARBK
;
;*************** END OF PROGRAM PROCEDURE *****************************
;
;  RESTORE CONTROL TO DOS - END OF PROGRAM
;
```



```
BELEND: MOV     DIGITS,0        ;CLEAR 'UNPAIRED DIGITS' HEX CHECK
        MOV     AL,07H          ;BAD PARMS IN PROGRAM - SOUND BELL
        CALL    PRINTER         ;PROGRAM ENDED WITH ERRORS!
PGMEND: CMP     DIGITS,0        ;WAS 'UNPAIRED' HEXCODES ENTERED?
        JNE     BELEND          ;SOUND BELL TO SIGNAL ERROR
        CMP     TESTPR,0        ;
        JE      DEFAULT         ;NO OUTPUT WAS PRODUCED - SEND DEFAULT
;
        RET                     ;RETURN TO DOS - END OF PROGRAM.
;
;*********************************************************************
;  NO PARMS WERE ENTERED - DEFAULT SETTING OF DOUBLE-STRIKE/EMPHASIZE
;*********************************************************************
;
DEFAULT: MOV    AL,47H  ;PUT 'DOUBLE-STRIKE' CODE IN OUTPUT REGISTER
        CALL    ESCAPE
        MOV     AL,45H  ;PUT 'EMPHASIZE' CODE IN OUTPUT REGISTER
        CALL    ESCAPE
        JMP     PGMEND  ;JUMP TO END-OF-PROGRAM ROUTINE
;
        START   ENDP
;
;********** ESCAPE SUBROUTINE - SEND ESCAPE CODE TO PRINTER ***********
;
ESCAPE  PROC    NEAR
        PUSH    AX      ;SAVE POTENTIAL CHAR. TO BE PRINTED ON STACK
        MOV     AL,1BH  ;MOVE ESCAPE CHAR.(1BH) TO OUT REG.
        CALL    PRINTER ;CALL PRINTER SUBROUTINE
        POP     AX      ;GET CHAR. TO BE PRINTED FROM STACK
        CALL    PRINTER ;CALL PRINTER OUTPUT ROUTINE
        RET             ;RETURN TO CALLING SUBROUTINE
ESCAPE  ENDP
;
;********* PRINTER SUBROUTINE - ALL PRINTING IS DONE HERE *************
;
;  SEND CHARACTER IN AL REGISTER TO PRINTER
;
```

```
PRINTER PROC    NEAR
        MOV     TESTPR,1        ;VALID OUTPUT HAS BEEN PRODUCED
        MOV     DX,0    ;SET REGISTER FOR PRINTER OUTPUT INTERRUPT
        MOV     AH,0    ;SET REGISTER FOR PRINTER OUTPUT INTERRUPT
        INT     17H     ;CALL PRINTER DRIVER IN BIOS
        RET             ;RETURN TO CALLING SUBROUTINE
PRINTER ENDP
;
;********* CONVERT INPUT PARMS TO HEXIDECIMAL NUMBERS *****************
;
HEXMATH PROC    NEAR            ;ROUTINE TO CONVERT PARM TO HEX NUMBERS
        CMP     DIGITS,0        ;0===> 1ST #   -   1===> 2ND #
        JNE     MATH2           ;JUMP & PROCESS 2ND #
        MUL     SIXTEEN         ;MULTIPLE 1ST # BY 16
        MOV     HEX,AL          ;CLEAR & STORE RESULT IN 'HEX'
        INC     DIGITS          ;1ST NUMBER PROCESSED
        RET                     ;RETURN TO PASTHRU ROUTINE
MATH2:  ADD     AL,HEX          ;TOTAL THE TWO HEX DIGITS
        MOV     DIGITS,0        ;CLEAR DIGIT VARIABLE FOR FUTURE PARMS
        CALL    PRINTER         ;SEND HEX # IN 'AL' REGISTER TO PRINTER
        RET                     ;RETURN TO PASTHRU ROUTINE
HEXMATH ENDP
;
;*********************************************************************
MAIN·   ENDS
        END     START
```

Computer dreams.



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OKI DOKEY: FROM PC TO OKIDATA 84

JEFF GARBERS

A program that translates the PC's codes for line-drawing characters into language the Okidata 84p can understand

Sometimes a printer and a personal computer don't speak quite the same language. An example of this problem occurs with the Okidata Microline 84p printer when it is used with an IBM PC or compatible. The Oki 84p has become a popular alternative to the IBM Dot Matrix and Graphics Printers. It is reasonably priced, quick, and offers an attractive correspondence-quality mode as well as other useful features. Unfortunately, it was not originally designed to work closely with the PC, so its graphics character set is quite different from the de facto standard established by IBM. What the PC displays as a solid vertical bar (character 179) comes out looking Japanese on the Oki. For a vertical bar, the Oki uses character 150, which would be displayed by a PC as an "O" with a circumflex.

Jeff Garbers is director of product development for Microstuf, Inc. in Atlanta, Georgia. He is coauthor of Crosstalk XVI.

Since the codes are not compatible, attempting to print any of the PC's non-ASCII characters results in a print-out that is distracting at best and unreadable at worst. The situation is especially annoying when printing screen dumps of programs that use the PC's line-drawing characters to form boxes or pictures on the screen. Checking the Oki manual reveals that the printer *can* print most of the necessary characters without

having to revert to complex graphics-printing procedures—it's just that the codes are different. All that would be necessary to fix things is a program to translate the PC's codes into the Oki's codes as the document is printed.

X2OKI, the program presented in listing 1, does just that. It intercepts any calls to the IBM BIOS parallel printer routine, checks to see if the character to be printed should be translated, and does the translation if it can. This version of the program supports only the line-drawing characters, but it could easily be expanded to do more. The program is well suited for modification and can serve as a base for interesting projects. (For instance, it could be used as an example by programmers wishing to develop a routine that would translate codes for printers other than the Oki 84p.)

USING THE PROGRAM

The IBM Macro Assembler is required to assemble this program. Use an editor to type it in (leave out the comments if desired) and give it the name X2OKI.ASM. Assemble and link it with the following steps (this article assumes that the programmer has MASM.EXE, LINK.EXE, and EXE2BIN.EXE):

```
MASM X2OKI;
LINK X2OKI;        ←will produce
                     a warning error
EXE2BIN X2OKI X2OKI.COM
DEL X2OKI.EXE
DEL X2OKI.OBJ
```

This routine will result in a runnable X2OKI.COM, which the user may wish to put on his boot disk and then incorporate into his AUTOEXEC.BAT file. If errors are encountered at any step in the assembly process, don't continue; go back, edit the source code, and start again. The only error to ignore is the warning error after the link step—that's perfectly normal.

To start the program, type X2OKI. The program will announce that it is installed and running. To toggle the translation feature (if, for example, the Okidata's graphics features are needed), type X2OKI again; the program will activate or deactivate (as appropriate) and will display its current status. The program has been tested and used extensively on the author's own system, but no guarantees are made as to its usefulness with any particular configuration of PC and printer.

SPECIAL TECHNIQUES

X2OKI is extensively commented, but there are a few notions that need special attention:

Borrowing the Interrupt Vector. Notice that when X2OKI first starts up, it stores the address of

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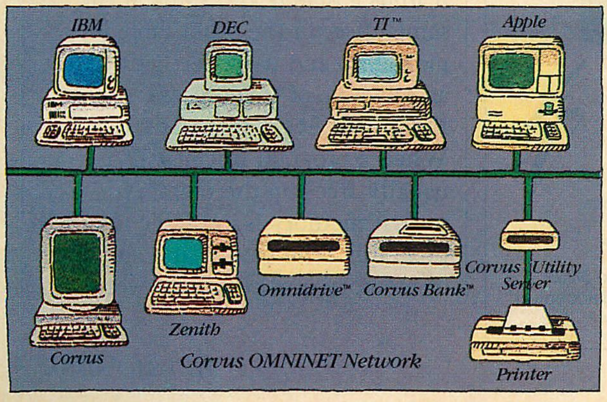

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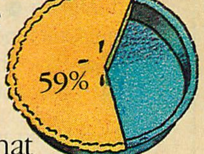

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the old INT 17H handler away for its future use. When its own work is complete, it calls the old handler before returning to its own caller. This technique is often referred to as "borrowing" the interrupt vector. In contrast, a program is said to "steal" the interrupt vector when it handles the interrupt itself and either returns directly to its caller or jumps off to a fixed position in the ROM BIOS, often leaving a previously installed caller out in the cold. Programs that steal interrupt vectors—especially the video, keyboard, and timer-handling vectors—are one of the major causes of incompatibility between different software packages. Obviously, stealing is to be avoided. The borrowing technique, if used properly, allows "chaining" of handlers and will help to ensure future usefulness.

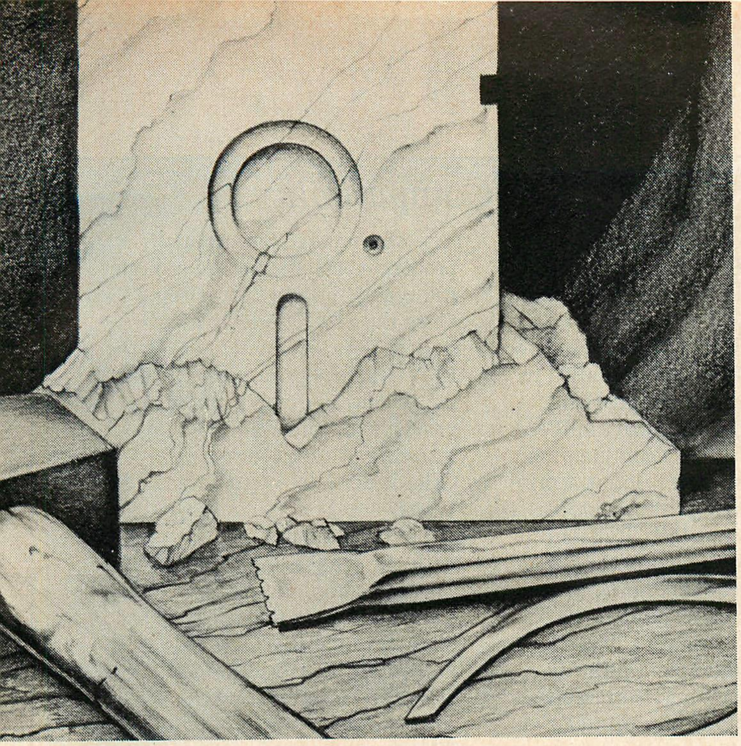
Using a Scan Table. There are two common ways of performing character translation: using look-up tables and using scan tables. With a look-up table, the program subtracts some constant value from the incoming character so as to make it an "offset" into a predefined table; for example, a program might subtract 65 from an alphabetic character to translate A to zero, B to 1, etc. The program then uses one of the 8088's indexed addressing modes to pick up the desired outgoing character from the table, as in the following code fragment:

```
sub al, 65         ; change 'A' TO 0,
                   ;'B' to 1, etc.
mov bl, al         ; we will use BX
                   ;as our offset
mov bh, 0          ; high half is
                   ;always zero
mov al, TABLE[bx]  ; pick up
                   ;the desired value
```

Look-up tables are appropriate when speed is a concern or when many of the characters in a particular range need to be translated.

Neither of these cases is appropriate in X2OKI—the speed is going to be limited by the printer's output capability anyway, and the program can handle only a few of the possible characters. The scan table approach is therefore used instead. In this method, there are two "parallel" tables—one containing codes for incoming characters that need to be changed and the other containing the desired outgoing characters. The program scans the table, and if it finds a match, the value at the same offset in the other table is picked up and used. See listing 1 for an example of this process.

End but Stay Resident. When a program finishes, DOS usually frees up the memory it used so that memory is available to other programs. The user would run out of memory quickly if this were not



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the case. X2OKI, however, needs to "stay resident" in memory so it is always ready for use. Otherwise, when a printer interrupt happens, if the handler has been overwritten by a subsequently loaded program, the system will crash.

Most programs stop with an INT 20H, which lets DOS free up the memory they used. X2OKI, however, ends with an INT 27H. This is a special method of exiting that informs DOS that part of the program that is about to stop needs to stay resident. It's described (briefly) in the DOS manual. Notice two special aspects of the way X2OKI uses this function:

1. The INT 27H is used only the first time the program is run. Otherwise, every time the user typed "X2OKI" another slice of memory would be used up. The logic that lets X2OKI determine if it has been run before is shown in listing 1.
2. X2OKI doesn't keep more code resident than it has to. The label LAST marks the last location in X2OKI that needs to stay resident. Everything after LAST is "transient" and can safely be flushed from memory when the program is done running.

Trying to use printers other than IBM's with the IBM PC can be frustrating and time-consuming. The program presented here should help programmers solve their translation problems and allow them to print what they want to print.

Okidata Plug 'N Play Compatibility

For people who have an Okidata ML92 or ML93 and who want IBM compatibility without programming, Okidata offers the Plug 'N Play interface kit for $49. These two replacement PROMs are installed in the printer's control circuit board, and the resulting Okidata-cum-IBM-Graphics printer has a combination of features from both printers. Correspondence quality printing, proportional spacing, and 160 CPS data processing mode are added to the IBM Graphics printer's repertoire. Regrettably, some standard Okidata features—notably, downline loadable character generation and printing at 12 and 6 CPI—are made unusable.

All of the Graphics printer's character spacing commands and printer modes, including bit-mapped graphics, are accepted by the Okidata, but their implementations differ slightly in a few cases. Character set 1 is completely supported. In character set 2, all of the Greek and Spanish characters, the mathematical symbols, and the graphics symbols are supported, but the card suit shapes (ASCII decimal codes 03-06) and some foreign characters (ASCII decimal 129 and 131-159) are not.

Underlining on the Okidata is continuous; the Graphics printer does not underline between words. The Okidata is designed for line spacing in increments of 1/72-inch or 1/144-inch, not 1/216-inch like the IBM Graphics printer. In order to approximate 1/216-inch spacing, the Okidata multiplies the number given in the Esc 3 or Esc J commands by 2/3 and uses 1/144-inch spacing. Because of rounding errors, there can be a slight gap or overlap in printed lines if the original number is not evenly divisible by 3.

Many programs, especially word processors, ask the user to indicate the type of printer that is being used. Once the Plug 'N Play Kit is installed, the user should specify the IBM Graphics printer, not the Okidata. Accompanying documentation provides additional instructions for inserting printer commands in VisiCalc, SuperCalc, WordStar, and Super Writer.

An instruction booklet supplied with the Plug 'N Play interface kit contains complete and clearly illustrated directions for installing the replacement PROMs. The only tools needed are a Phillips-head screwdriver and some marking tape. The control circuit board containing the PROMs is removed from its slot at the rear of the printer; to do this, seven connectors must be unplugged from the circuit board. The marking tape is used to label each connector with its socket number in order to make reinsertion easier. After the existing PROMs are extracted, the replacement PROMs are installed, the circuit board is reseated, and the playing begins.

Because the plugging process takes about 15 minutes, switching between the IBM Graphics printer emulation and the pure Okidata environment is not easy. Although some of the Okidata ML92 and ML93 features cannot be used with the Plug 'N Play interface kit installed, the replacement PROMs yield a high degree of IBM compatibility without any programming effort, and with the associated benefits that no user memory is dedicated to a resident printer program and no processing overhead is incurred in translating codes.

—Julie Anderson

Listing 1: X2OKI.ASM

```
*************************************************************************
* This program traps the printer output interrupt (17H), and           *
* translates outgoing IBM-style line drawing characters to codes       *
* compatible with the Okidata 84p.                                     *
*                                                                      *
* Since the 84p doesn't fully implement all double-line characters,    *
* we translate everything into single-line graphics.  Other            *
* graphics characters (hearts, happy faces, etc.) are not supported    *
* in this program.                                                     *
*                                                                      *
* The utility should be disabled prior to running any program (such    *
* as Lotus 1-2-3) that depends on the Okidata graphics character       *
* set or uses the Okigraph graphics printing facility.                 *
*                                                                      *
* USE:  Giving the command "X2OKI" for the first time will install the *
* conversion utility and produce the report "X2Oki installed and       *
* running."  Thereafter, giving the "X2Oki" command will toggle the    *
* translation feature off and on, reporting "X2Oki temporarily         *
* deactivated" or "X2Oki reactivated."                                 *
*                                                                      *
*                                                                      *
* Copyright (C) 1983 Jeffrey P. Garbers.   All rights reserved.        *
*************************************************************************


CSEG        segment para public 'CODE'
   assume  cs:CSEG, ds:CSEG


; The printer interrupt number is defined by the PC to be 17H.
```

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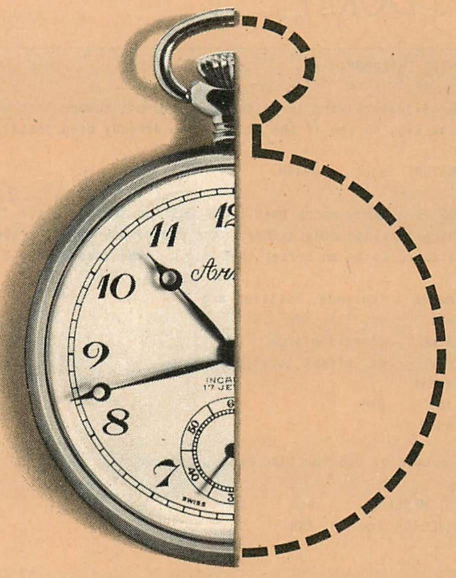

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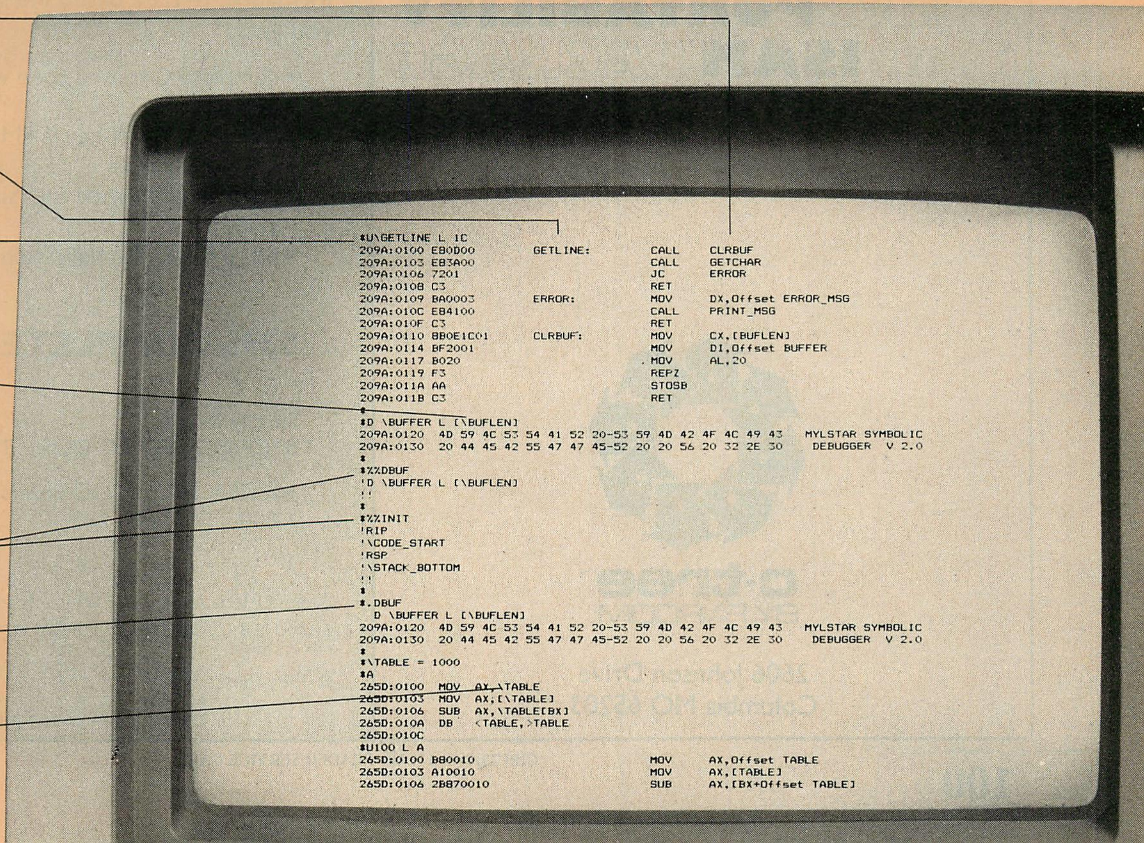

```
PRINTER_INTERRUPT  equ      17H

; The signature word is an arbitrary 16-bit number that we'll use in
;  checking to see if the utility has already been installed.

SIGNATURE  equ      0944H

; DOS is a handy macro that calls DOS for service.  Its first argument
;  is a function code number.  The second one (if it's there) is
;  assumed to be an offset that needs to be loaded into DX.

DOSmacro   fcn_code, location_arg
   mov     ah, fcn_code
   ifnb    <location_arg>
   mov     dx, offset location_arg
   endif
   int     21H
   endm

; A couple of DOS function codes, defined.

PRINT_MESSAGE      equ      09H
SET_VECTOR equ     25H

; Programs to be passed through the EXE2BIN utility need to start at
;  address 100H.

   org     100H             ; goes thru EXE2BIN

; Since PC-DOS will always start us at 100H, we need to do a jump
; right away to get around the data and interrupt-handling stuff
; and get right to the program initialization.

HOME:      jmp      START           ; skip around all the data space


; Data areas for X2OKI.
```

```
; BIOS_HANDLER contains the doubleword address which used to be the
;  printer interrupt handler.  We leave here through the old vector,
;  so any other interceptors that may have been installed (spoolers,
;  etc.) will still work properly.

BIOS_HANDLER       dd      ?       ; address of former int handler

; The translation tables.  The first table (PC_CHARS) contains the
;  IBM-defined codes for the single and double line box drawing
;  characters.  The parallel second table (OKI_CHARS) contains the
;  Okidata 84p codes for those characters.  Notice that the lines of
;  the OKI_CHARS table are quite similar; this is because PC double-
;  line characters are translated to Oki single-liners.
;  NUMBER_OF_CHARS just lets the assembler figure out how many of
;  these we have to look through.

; In order to expand the conversion tables, just add codes to both
;  tables as needed, making sure that you keep the order straight.

PC_CHARS equ  this byte
    db   218,194,191,195,180,192,193,217,196,179,197 ;sng boxes
         db   201,203,187,204,185,200,202,188,205,186,206 ; dbl boxes
         db   214,210,183,199,182,211,208,189,215   ; combinations
    db   213,209,184,198,181,212,207,190,216        ; more combos

NUMBER_OF_CHARS    equ     $-PC_CHARS

OKI_CHARS  equ      this byte
           db       152,145,153,147,146,154,144,155,149,150,143
           db       152,145,153,147,146,154,144,155,149,150,143
           db       152,145,153,147,146,154,144,155,143
           db       152,145,153,147,146,154,144,155,143

; An area to save the incoming character, which we need to preserve.

INCOMING_CHAR      db      ?
;*********************************************************************
;          START OF X2Oki CODE
;*********************************************************************
```

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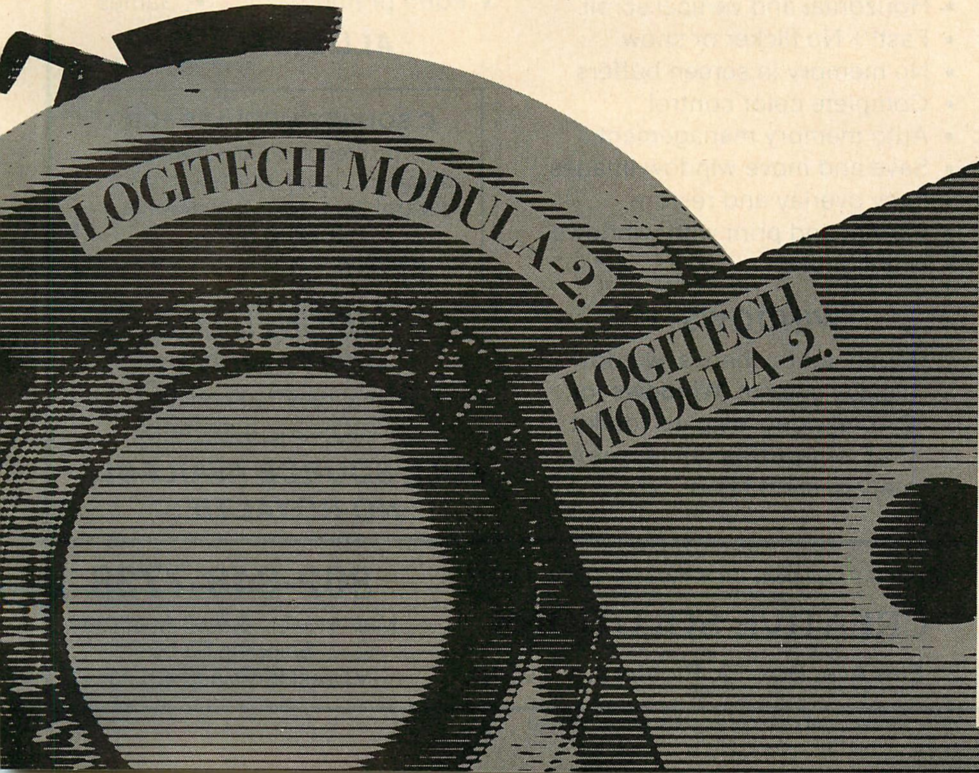

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```
MAIN        proc    far

; The lodged part.  This translates Oki chars to our chars.

HANDLER:    jmp     short HANDLE1                       ; skip data

; Don't change that jump or put anything between here and the INSTALLED
;  and ACTIVE variables.  Later we assume that they come right after
;  the start of the handler.

; The INSTALLED variable is just an instance of the signature word.
;  We can check for the presence of this word to see if the driver
;  has already been installed.

INSTALLED  dw      SIGNATURE

; ACTIVE is 1 if the utility is active.  If it's zero, we just pass
;  characters right through and don't do any conversion.

ACTIVE             db      1                              ; we are active


; Watch for the use of the CS: override prefixes in here.  When we
;  get control, the only segment register we know about is CS (the
;  Code Segment), so we'll use it to check to see if we're running.


HANDLE1:

   mov      cs:INCOMING_CHAR, al    ; save incoming character


; There are three cases in which we want to do nothing here and just
;  skip right out to the HANDLEdone location (which passes control
;  off to the old BIOS handler).  Those are:
;
;  (1) Utility not currently active.
```

```
   cmp      cs:ACTIVE, 1                        ; are
   jnz      HANDLEdone                          ; we're not running

;  (2) Request to BIOS is not a "please print character" call,
;          but rather a status or other request.

   or       ah, ah
   jnz      HANDLEdone                          ; not a print call

;  (3) The character to be printed has a value below 128, and
;          therefore can't be a line drawing character. Testing
;          for this allows us to pass most of the printing
;               characters through quickly without having to scan
;               the table.

   test     al, 80H
   jz       HANDLEdone                ; not a graphics char

; Okay, we have a character we may wish to do something to.  First,
;  let's save a few registers.

   pushf                              ; need to save this because
   push     es                        ; we're going to mess with
   push     cx                        ; the direction flag during
   push     di                        ; our scanning.


; The following two-instruction sequence gets a copy of CS into
;  the ES register.  We will be scanning the table that exists in
;  this segment.
   push     cs
   pop      es

;  When scanning a table, you must:

;  (1) Point ES:DI to the start of the table (we've already
;          done ES)

   mov      di, offset PC_CHARS
```

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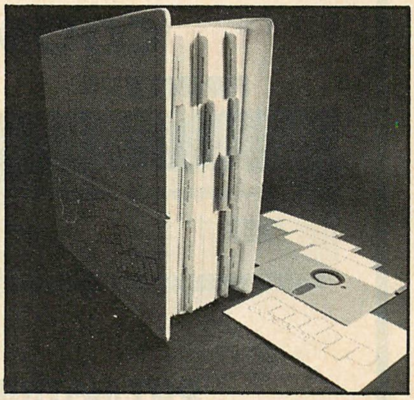

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```
;  (2) Set CX to the size of the table

    mov     cx, NUMBER_OF_CHARS

;  (3) Set or clear the direction flag to indicate the
;          direction of the scan (normally CLD)

    cld

; Now everything is set up for the scan.  Let's use the nice
;  8088/8086 instructions to do it.  The one we're going to use will
;  scan bytes until it finds a match, or until it runs out of table.
;  The REPNZ prefix means "repeat this instruction while there isn't
;  a match."

    repnz   scasb                          ; look it up
    jnz     HANDLEscanDone                 ; couldn't find it

; Now DI points one past the matching entry (remember that DI is
;  always adjusted, even if we find a match.  We now need to convert
;  DI into an offset into the OKI_CHARS table.  Since we started DI
;  at the offset of PC_CHARS, and since we're one beyond our match,
;  we can subtract one more than our starting spot to find our offset
;  into the OKI_CHARS table.  Messy?  A little.  Work it out on
;  paper if you have trouble picking up on this notion.

    sub     di, offset PC_CHARS+1          ; make it an offset
    mov     al, es:OKI_CHARS[di]

; Okay, either we've translated the character or we don't know how
;  to translate it.  Recover the registers we saved, and split out
;  to the original BIOS handler.

HANDLEscanDone:

    pop     di
    pop     cx
```

```
    pop     es
    popf

; Notice again the use of the CS override here.  We have not used the
;  DS register at all during this handler.

HANDLEdone: pushf                          ; must PUSH before manually
;                                              calling an int. handler
    call    cs:BIOS_HANDLER
    mov     al, cs:INCOMING_CHAR           ; recover original character codes
    iret                                   ; and return to caller

; Since we're going to be doing an end-but-stay-resident, we'll
;  need to mark where the handler part ends.  The label LAST will
;  serve nicely.

LAST        equ     this byte                          ; last part of
                                                       ; resident

;*****************************************************************
;           TRANSIENT PART of X2Oki
;
;  See text of article about the difference between the
;       resident and transient parts of an interceptor program.
;
;*****************************************************************

START:      push    ds
    xor     ax, ax
    push    ax                                 ; .COM programs start
                                               ; like this

; AX is already zero, and we want to look at an interrupt handler's
;  address (which lives in segment 0000).  So let's just move our
;  zeroed AX into ES for snooping purposes.  We'll set SI to 17H
;  (the printer service interrupt) times 4 (the number of bytes in
;  each handler address).
```

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```
        mov     es, ax
        mov     si, PRINTER_INTERRUPT*4        ; point to
                                                ; installed address

; First, we'll get the address that's there so we can call it later.

        lods    word ptr es:[si]
        mov     word ptr BIOS_HANDLER, ax
        lods    word ptr es:[si]
        mov     word ptr BIOS_HANDLER+2, ax

; We've now got the old handler in BIOS_HANDLER.  Pick it up as a
;  32-bit pointer so we can see who's there.

        les     si, BIOS_HANDLER

; We know that if it's our handler, there's the SIGNATURE word two
;  bytes beyond the beginning of the handler (our handler starts
;  with a short jump).  See if it's us, and if it isn't, install us.

        cmp     word ptr es:[si+2], SIGNATURE   ; this us?
        jnz     INSTALL                         ; not yet--install us

; Toggle the on/off setting.  The ACTIVE flag lives four bytes beyond
;  the handler--let's flop its setting.

        mov     al, es:[si+4]           ; pick up running flag
        xor     al, 1                   ; flip the bit
        mov     es:[si+4], al           ; replace it

; Okay, we now have AL as the new state.  Give a message saying
;  our current state.

        mov     dx, offset m$RUNNING    ; for now, assume it's running
        cmp     al, 1                   ; were we right?
        jz      MSG_N_SPLIT             ; yes, take this
        mov     dx, offset m$OFFNOW     ; report "off"

; When we get here, DX is pointing to a status message.  Print it
;  and leave.

MSG_N_SPLIT:        DOS     PRINT_MESSAGE   ; "print message" function
    ret                                     ; goodbye!

; If we get to this spot, it's the first time that the program has
;  been run.  Install our own handler into the interrupt vector,
;  report this event with a message, and let DOS know we want to stay
;  around.

INSTALL:

        mov     al, PRINTER_INTERRUPT   ; printer interrupt, please
        DOS     SET_VECTOR_HANDLER      ; DOS function 25h is "set
                                        ; interrupt"

        DOS     PRINT_MESSAGE m$NOWREADY

; Everything's complete.  Leave the program via INT 27H with DX
;  pointing to the end of the resident part, and DOS will keep
;  the important stuff around while freeing up the memory occupied
;  by the part that's not part of the interrupt handler per se.

        mov     dx, offset LAST+1       ; point to the end of the
                                        ; fixed part
        int     27H                     ; end-but-stick-around


; Three status report messages.

m$NOWREADY db       "X2Oki installed and running.$"
m$RUNNING  db       "X2Oki reactivated.$"
m$OFFNOW   db       "X2Oki temporarily deactivated.$"

MAIN        endp

CSEG        ends
    end     HOME
```

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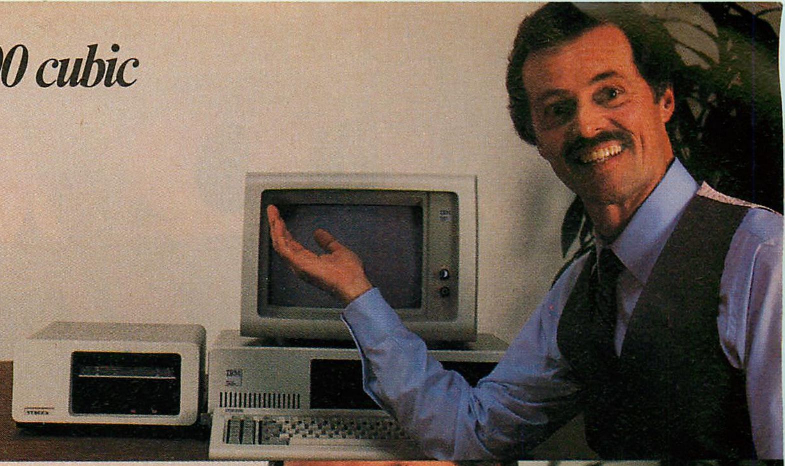

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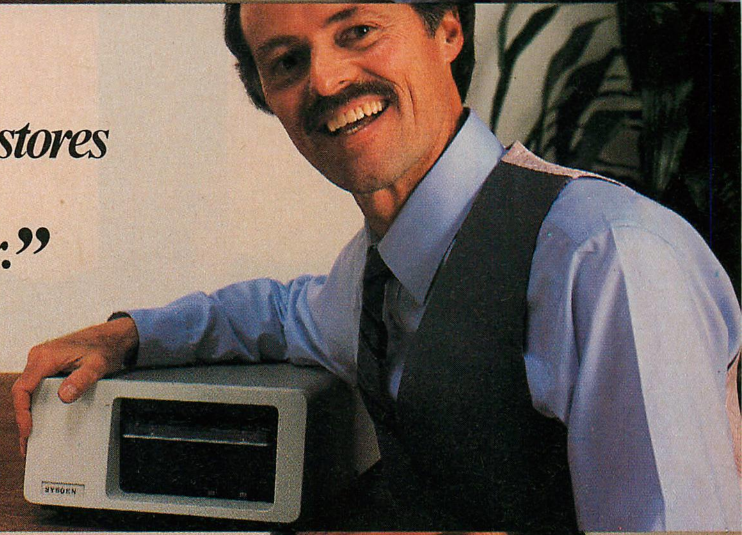

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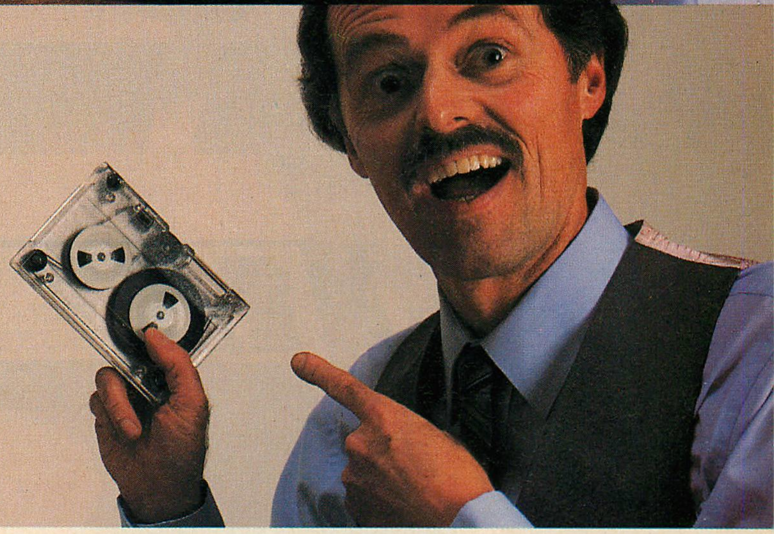

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                                           CX=0000     SI=0000     ES=1985
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===============PL ZR  NC NV  UP  NA PE  EI========================IP=0001===
2001:0000    53                24 IO_INIT:  PUSH   BX                          ;TAG A LINE
2001:0001    9BDEC2                         FADDP  ST(2),ST
2001:0004    BB3100                         MOV    BX,Offset VECTOR_TABLE_2
2001:0007    803E5E~           34           CMP    DOS_VERSION_NUM,'2'         ;BREAKPOINT SET
2001:000C    7305                           JAE    TRASH_IT
2001:000E    BB0100                         MOV    BX,Offset VECTOR_TABLE_1
2001:0011    EB02                           JMP    Short LONG_LABELS_ARE_OK_AS_YOU_LIKE
2001:0013    F2AB      00777   TRASH_IT:    REPNZ  STOSW                       ;STOP 777th TIME
2001:0015                      LONG LABELS_ARE_OK_AS_YOU_LIKE:
2001:0015    8DAD63~                        LEA    BP,WIERD_CODE + 2[DI]
2001:0019    240C                           AND    AL,00011100B                ;CHANGE RADIX
2001:001B    45                             DB     69
                          MEMORY DUMP
>>DOS_VERSION_NUM              Absolute Address=03C9E   Segment:Offset=03C4:005E
1984:0050    41 53 43 49 49 20 53 55-50 50 4F 52 54 20 32 20   ASCII SUPPORT 2
1984:0060    20 2D 2D 20 43 6F 64 65-53 6D 69 74 68 2D 38 36    -- CodeSmith-86
1984:0070    20 4D 41 4B 45 53 20 44-45 42 55 47 47 49 4E 47    MAKES DEBUGGING
1984:0080    20 41 20 42 4C 41 53 54-21 20 20 20 20 20 20 20    A BLAST!
                                                                     WNDW 2  LVL 1
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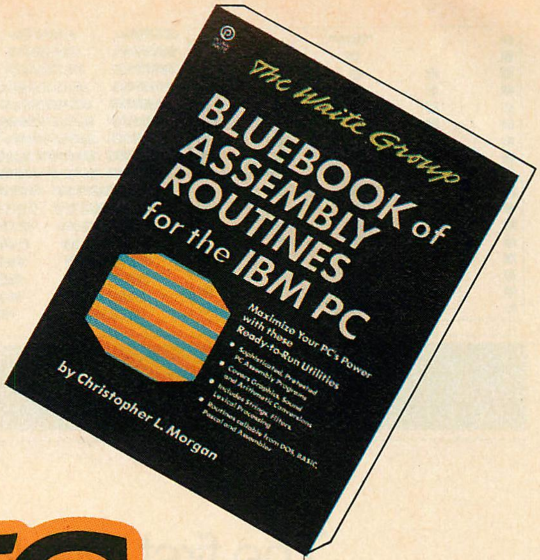

Strings

An excerpt from Bluebook of Assembly Routines for the IBM PC

String manipulation is an important part of computing that is useful in text editing and database management. The assembly language routines in this article are fundamental to both of these application areas.

The first two routines, called LOWERCASE and UPPERCASE, convert characters within a string from upper-case to lower-case and from lower-case to upper-case. The next two—STRSEARCH and STRINSERT—each require two input strings. STRSEARCH searches for a copy of one string in another, and STRINSERT inserts a copy of one string within another.

Next are two routines—LEXSEARCH and LEXINSERT—that require a string and a *list* of strings as input. These routines deal with lexigraphically ordered strings. *Lexigraphical order* is another name for alphabetical order. It is important to understand, however, that for these routines the individual characters are ordered according to their ASCII code. For example, all upper-case letters precede lower-case letters. If lexigraphical ordering of the words is desired, the routines can be changed so that all lower-case letters are converted to upper-case before being used in comparisons.

Editor's Note: This is the third excerpt from Bluebook of Assembly Routines for the IBM PC, *a Waite Group book by Christopher L. Morgan. (Morgan is also the author, with Mitchell Waite, of* 8086/8088 16-Bit Microprocessor Primer *and* Graphics Primer for the IBM PC.) *This book is part of the New American Library series of IBM PC computer-language books that have been issued under the Plume/Waite imprint.*

The first excerpt appeared in the March issue of PC Tech Journal *and dealt with assembly routines to control the graphics capabilities of the IBM PC. In April, the second excerpt was published; it concerned assembly routines to control sound on the IBM PC.* —*WF*

LEXSEARCH searches for the proper place to insert a string in a lexigraphically ordered list of strings, and LEXINSERT inserts a string in the proper place in a lexigraphically ordered list of strings. LEXINSERT is built upon the earlier routines in that it calls LEXSEARCH to find the proper spot and then calls STRINSERT to make the insertion.

The last three routines—COMPARE, SWITCH, and BSORT—work with string arrays. COMPARE is used to compare two strings of equal length. It enables the user to compare two different entries of the same string array. SWITCH is used to switch two strings of the same length—for example, two different entries of the same string array. Both of these routines are needed by BSORT, which performs a bubble sort of a string array. Although bubble sort is not one of the fastest methods of sorting, it is easy to program, as is illustrated by the BSORT routine. Because this routine is written in assembly language, it runs quickly despite the inherent slowness of the method.

These routines take advantage of the 8088 string instructions. Notice how easy string scanning and comparing is when using these string instructions; the COMPARE routine has only one instruction besides the PUSHes and POPs to save the registers.

Listing 1 LOWERCASE

FUNCTION: This routine converts the characters in a string to lower-case.
INPUT: Upon entry DS:BX points to a string. The first two bytes in the string form a 16-bit integer that specifies the length of the string. The remaining bytes contain the characters of the string.
OUTPUT: Upon exit all alphabetical characters of the string are lower-case.
REGISTERS USED: No registers are modified.
SEGMENTS REFERENCED: Upon entry the data segment must contain the string.
ROUTINES CALLED: None
SPECIAL NOTES: None
CODE:

```
; ROUTINE TO CONVERT STRING TO LOWER CASE
;
lowercase   proc     far
;
    push    bx              ; save registers
    push    cx
    push    ax
;
; get the length
    mov     cx,[bx]         ; first two bytes contain the length
    inc     bx              ; point to beginning of text
    inc     bx
;
; loop through the bytes of the string
lowercase1:
    mov     al,[bx]         ; get the character
    cmp     al,'A'          ; below the upper case characters?
    jb      lowercase2      ; skip if so
    cmp     al,'Z'          ; above the upper case characters?
    ja      lowercase2      ; skip if so
;
    or      al,20h          ; OR bit 5 into the byte
;
lowercase2:
    mov     [bx],al         ; store the character
    inc     bx              ; point to next character
    loop    lowercase1
;
    pop     ax              ; restore registers
    pop     cx
    pop     bx
    ret
;
lowercase endp
```

Listing 2 UPPERCASE

FUNCTION: This routine converts the characters in a string to upper-case.
INPUT: Upon entry DS:BX points to a string. The first two bytes in the string form a 16-bit integer that specifies the length of the string. The remaining bytes contain the characters of the string.
OUTPUT: Upon exit all alphabetical characters of the string are upper-case.
REGISTERS USED: No registers are modified.
SEGMENTS REFERENCED: Upon entry the data segment must contain the string.
ROUTINES CALLED: None
SPECIAL NOTES: None
CODE:

```
; ROUTINE TO CONVERT STRING TO UPPER CASE
;
uppercase   proc     far
;
    push    bx              ; save registers
    push    cx
    push    ax
;
; get the length
    mov     cx,[bx]         ; first two bytes contain the length
    inc     bx              ; point to beginning of text
    inc     bx
;
; loop through the bytes of the string
uppercase1:
    mov     al,[bx]         ; get the character
    cmp     al,'a'          ; below the lower case characters?
    jb      uppercase2      ; skip if so
    cmp     al,'z'          ; above the lower case characters?
    ja      uppercase2      ; skip if so
;
    and     al,5Fh          ; mask out bit number 5
;
uppercase2:
    mov     [bx],al         ; store the character
    inc     bx              ; point to next character
    loop    uppercase1
;
    pop     ax              ; restore registers
    pop     cx
    pop     bx
    ret
;
uppercase endp
```

Listing 3 STRSEARCH

FUNCTION: This routine searches for a copy of a source string within a destination string.
INPUT: Upon entry DS:BX points to a source string and ES:DX points to a destination string. Each string begins with a 16-bit integer that specifies the length of the string.
OUTPUT: Upon exit AL contains a return flag (0=not found, 0FFh=found)— and if the search was successful DX contains the location of the first byte of the match in the destination.
REGISTERS USED: Only AX and DX are modified. They are used for output.
SEGMENTS REFERENCED: Upon entry the data segment must contain the source string, and the extra segment must contain the destination string.
ROUTINES CALLED: None
SPECIAL NOTES: None
CODE:

```
;   ROUTINE TO SEARCH FOR ONE STRING WITHIN ANOTHER
;
strsearch   proc    far
;
    push    si              ; save registers
    push    di
    push    cx
;
; get length of destination and point to first byte
    mov     si,dx           ; use source index
    lodsw                   ; get the length of destination
    mov     cx,ax           ; use the length as a count
    mov     dx,si           ; text begins here
;
strsearch1:
; point indices to beginning of source and destination
    mov     si,bx           ; load source index
    mov     di,dx           ; load destination index
;
; scan for match
    mov     al,[si+2]       ; get the first character
    cld                     ; forward direction
    repnz   scasb           ; scan for match
    jcxz    strsearch2      ; quit if found no match
;
; got a match of first characters - now check the entire string
    mov     dx,di           ; save current destination loc
    dec     di              ; beginning of word
    lodsw                   ; get length of source
    xchg    cx,ax           ; use source count and save dest count
    repz    cmpsb           ; compare the two strings
    jcxz    strsearch3      ; it's a match if no more source
;
; continue the scan
    xchg    cx,ax           ; use destination count
    jmp     strsearch1      ; back for more scanning of dest
;
; no match is possible
strsearch2:
    mov     al,0            ; unsuccessful outcome
    jmp     strsearchexit
;
; found a match
strsearch3:
    dec     dx              ; point to beginning of match
    mov     al,0FFh         ; successful match
    jmp     strsearchexit
;
```

```
strsearchexit:
    pop     cx              ; restore registers
    pop     di
    pop     si
    ret
;
strsearch   endp
```

Listing 4 STRINSERT

FUNCTION: This routine inserts a source string in a specified place in a destination string.
INPUT: Upon entry DS:BX points to the source string, ES:BP points to the destination string, and ES:DX points to the spot in the destination string at which the source is to be placed. Each string begins with a 16-bit integer specifying the string's length.
OUTPUT: Upon exit the destination string has the source string inserted in the proper place. The length of the destination string is increased.
REGISTERS USED: No registers are modified.
SEGMENTS REFERENCED: Upon entry the data segment must contain the source string; the extra segment must contain the destination string.
ROUTINES CALLED: None
SPECIAL NOTES: None
CODE:

```
; ROUTINE TO INSERT ONE STRING WITHIN ANOTHER
;
;addressing equates
essorc      equ     es:[si]         ; equate for source in extra seg
dsdest      equ     byte ptr[di]    ; equate for usual destination

strinsert   proc    far
;
    push    si              ; save registers
    push    di
    push    cx
    push    ax
;
; find current end of destination string
    mov     si,bp           ; start of string
    add     si,es:[si]      ; point to next to last byte
    inc     si              ; adjust for length information
;
; find new end of destination string and update length
    mov     di,si           ; get old end of destination
    mov     ax,[bx]         ; get length of source
    add     di,ax           ; new end of destination
    add     es:[bp],ax      ; new length of destination
;
; move tail of destination string out of the way
    mov     cx,si           ; SI - DX + 1 is the count
    sub     cx,dx
    inc     cx
    std                     ; backward direction
repmovs     dsdest,essorc   ; move the tail
;
; move source string into place
    mov     di,dx           ; destination of move
    mov     si,bx           ; source of move
    cld                     ; forward direction
    lodsw                   ; length of source
    mov     cx,ax           ; the count
    rep     movsb           ; make the string move
;
strinsertexit:
    pop     ax              ; restore registers
    pop     cx
```

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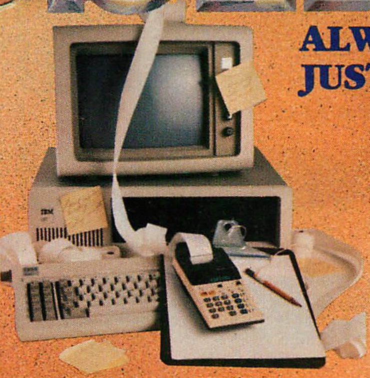

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```
    pop     di
    pop     si
    ret
;
strinsert   endp
```

Listing 5 LEXSEARCH

FUNCTION: This routine searches a lexigraphically (alphabetically) ordered list of word strings for the proper place to insert a new word.
INPUT: Upon entry DS:BX points to a source word string, and ES:BP points to the ordered list of words. The source word string begins with a 16-bit integer that specifies the length of the string and then continues with the bytes of the string. The last byte must be a carriage return symbol (ASCII 13). The destination list of words begins with a 16-bit integer that specifies the length of the string in character bytes and continues with words that consist of ASCII characters. The words are separated by carriage return symbols (ASCII 13).
OUTPUT: Upon exit AL contains a return flag (O=not found, OFFh=found). If the search was successful ES:DX contains the location of the proper place to insert the new word. If the word was already present then ES:DX points to the location of this word in the destination string.
REGISTERS USED: Only AX and DX are modified because they are used for output.
SEGMENTS REFERENCED: Upon entry the data segment must contain the source string; the extra segment must contain the destination word list.
ROUTINES CALLED: None
SPECIAL NOTES: None
CODE:

```
; ROUTINE TO SEARCH FOR A WORD IN AN ORDERED LIST OF WORDS
;
lexsearch  proc    far
;
    push    si              ; save registers
    push    di
    push    cx
;
; point to beginning of list and get its length
    mov     di,bp           ; beginning of list
    mov     cx,[di]         ; get length
    inc     di
    inc     di
;
; compare source word with words in the list
;
lexsearch1:
;
    mov     dx,di           ; save beginning of dest word
;
; forward direction
```

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```
    cld                         ; forward direction
;
; point to beginning of source
    mov     si,bx               ; point to beginning of source
    inc     si
    inc     si
;
; compare source word with a word of the list
lexsearch2:
;
; check for end of list
    jcxz    lexsearch5          ; end of list - insert it
;
; set up carriage return as character for scanning
    mov     al,13               ; scan for carriage return
;
; check for end of source word
    cmp     [si],al             ; source byte = carriage return?
    je      lexsearch4          ; end of source word found
;
; check for end of destination word
    cmp     es:[di],al          ; dest byte = carriage return?
    je      lexsearch3          ; no match - go to next word
;
; compare character by character
    dec     cx
    cmpsb                       ; check for match
    je      lexsearch2          ; matched - check next character
    jb      lexsearch5          ; too high - this is the place
;
; scan for next carriage return
lexsearch3:
    repnz   scasb               ; scan until carriage return
    jmp     lexsearch1          ; next word
;
; end of source word was found
lexsearch4:
    cmp     [di],al             ; dest character = carriage return?
    je      lexsearch6          ; end of destination word?
;
; found a spot to insert the word
lexsearch5:
    mov     al,0FFh             ; success
    jmp     lexsearchexit
;
; word is already present
lexsearch6:
    mov     al,00h              ; already there
    jmp     lexsearchexit
;
lexsearchexit:
    pop     cx                  ; restore registers
    pop     di
    pop     si
    ret
;
lexsearch  endp
```

Listing 6 LEXINSERT

FUNCTION: This routine inserts a word string in the proper place in a lexigraphically (alphabetically) ordered list of words.

INPUT: Upon entry DS:BX points to a source word string; ES:BP points to the ordered list of words. The source word string begins with a 16-bit integer that specifies the length of the string. The last byte must be a carriage return symbol (ASCII 13). The destination list of words begins with a 16-bit integer that specifies the length of the string and continues with words that consist of ASCII characters. The words are separated by carriage return symbols (ASCII 13).

OUTPUT: Upon exit the string is inserted properly.

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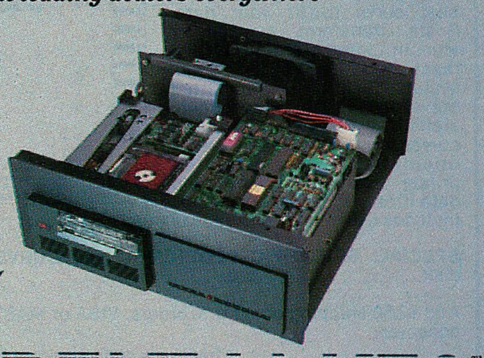

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REGISTERS USED: No registers are modified.
SEGMENTS REFERENCED: Upon entry the data segment and the extra segment must be equal, and they must contain the source string and the destination word list.
ROUTINES CALLED: LEXSEARCH, STRINSERT
SPECIAL NOTES: None
CODE:

```
; ROUTINE TO INSERT A WORD IN AN ORDERED LIST OF WORDS
;
lexinsert  proc    far
;
    push    ax                  ; save registers

    call    lexsearch           ; search for match
    cmp     al,0                ; already there?
    je      lexinsertexit       ; skip if so
    call    strinsert           ; insert the new word
;
lexinsertexit:
    pop     ax                  ; restore registers
    ret
;
lexinsert  endp
```

Listing 7 COMPARE

FUNCTION: This routine compares two strings of the same length.

INPUT: Upon entry DS:SI points to one string (the source) and DS:DI points to a second string (the destination). Both strings have lengths given by CX.
OUTPUT: Upon exit the flags specify the relation of the source to the destination:

- l = source string is less than destination string
- e = source string is equal to destination string
- g = source string is greater than destination string

REGISTERS USED: Only AX is modified.
SEGMENTS REFERENCED: Upon entry the data segment contains the source string and the extra segment contains the destination string.
ROUTINES CALLED: None
SPECIAL NOTES: None
CODE:

```
; ROUTINE TO COMPARE TWO STRINGS
;
compare    proc    far
;
    push    si                  ; save registers
    push    di
    push    cx
;
    repz    cmpsb               ; one compare does it!
;
    pop     cx                  ; restore registers
    pop     di
    pop     si
    ret
;
compare    endp
```

Listing 8 SWITCH

FUNCTION: This routine switches two strings.
INPUT: Upon entry DS:SI points to one string (the source) and ES:DI points to a second string (the destination). Both strings have lengths given by CX.
OUTPUT: Upon exit the strings are switched.
REGISTERS USED: No registers are modified.
SEGMENTS REFERENCED: Upon entry the data segment contains the source string and the extra segment contains the destination string.
ROUTINES CALLED: None
SPECIAL NOTES: None
CODE:

```
; ROUTINE TO SWITCH TWO STRINGS
;
switch      proc    far
;
    push    si              ; save registers
    push    di
    push    cx
    push    ax
;
    cld                     ; forword direction
switch1:
    mov     al,[di]         ; get byte from destination
    movsb                   ; move from source to destination
    mov     es:[si-1],al    ; put byte in source
    loop    switch1         ; loop back for more
;
    pop     ax              ; restore registers
    pop     cx
    pop     di
    pop     si
    ret
;
switch      endp
```

Listing 9 BSORT

FUNCTION: This routine sorts a string array by using bubble sort.
INPUT: Upon entry DS:SI points to a string array, CX contains the number of entries in the array, and DX contains the size of each entry.
OUTPUT: Upon exit the array is sorted.
REGISTERS USED: No registers are modified.
SEGMENTS REFERENCED: Upon entry the data segment and the extra segment must be equal and must contain the string array.
ROUTINES CALLED: COMPARE, SWITCH
SPECIAL NOTES: None
CODE:

```
; ROUTINE TO SORT A STRING ARRAY
;
bsort       proc    far
;
    push    si              ; save registers
    push    di
    push    cx
    push    ax
;
```

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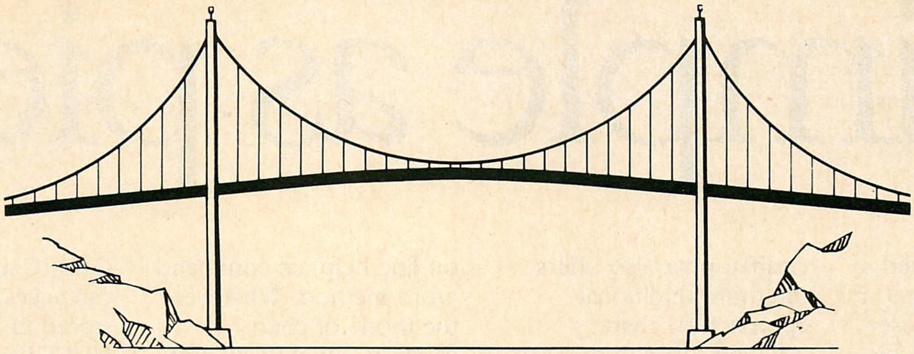
```
; adjust count for one less than number of items
     dec      cx              ; adjust the count
;
; outer loop - for SI = 1 TO N-1
bsort1:
     push     cx              ; save the count
     mov      di,si           ; destination points to source
;
; inner loop - for DI = SI+1 to N
bsort2:
     push     cx              ; save the count
     add      di,dx           ; point to next destination
     mov      cx,dx           ; entry length
     call     compare         ; compare the strings
     jle      bsort3          ; skip if source <= dest
     call     switch          ; switch if not
bsort3:
     pop      cx              ; restore the count
     loop     bsort2
;
     add      si,dx           ; point to next source
     pop      cx              ; restore the count
     loop     bsort1
bsortexit:
     pop      ax              ; restore registers
     pop      cx
     pop      di
     pop      si
     ret
;
bsort    endp
```



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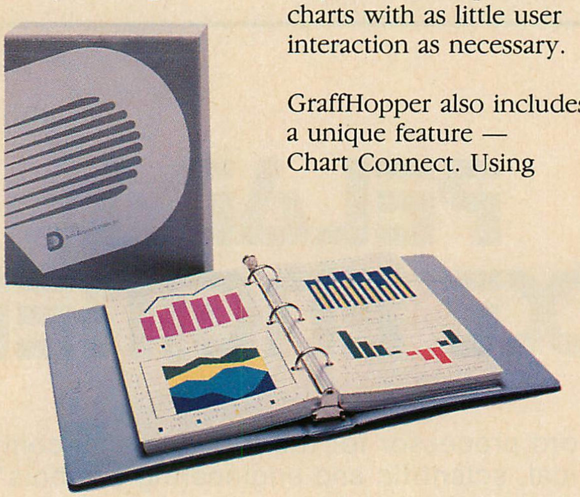

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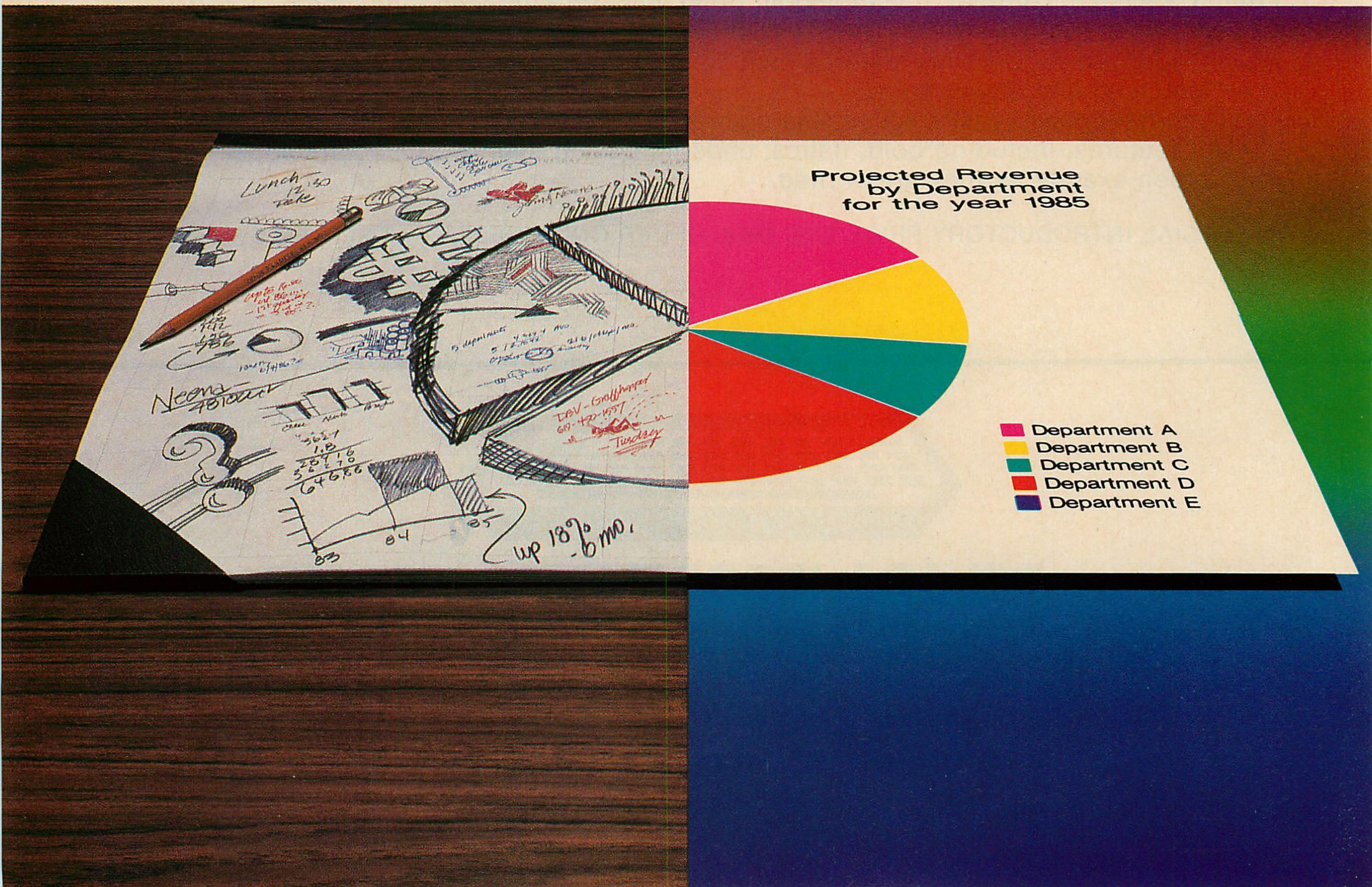

LIFE IS SIMPLE WITH APL

This little-known, love-it-or-leave-it language attacks the game of Life with ease.

PARDNER WYNN

Programmers who have used APL are rarely ambivalent about it. This is a programming language to either love or hate. "Learn a proper language, not APL," say its detractors, while enthusiastic APL users react quite differently. "Keep doing things the hard way, or start using APL," they advise.

I paid my money, took my chances, and rapidly became an APL enthusiast. APL is to other programming languages what poetry is to prose: concise, expressive, and versatile. It is easier to use than "proper" programming languages for two reasons: it has an interactive, extensible programming environment and simple, consistent data handling.

BASIC programmers, when first exposed to APL, undoubtedly will notice several similarities in BASIC and APL. Both languages are interactive, have commands to store and retrieve programs from disk files, include built-in program editing facilities, and

---

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have a host of math, character, program control, and program debugging functions.

This apparent similarity is misleading, however. APL takes these common features far beyond the capabilities of BASIC. APL workspaces simplify the management of programming projects. The language can be extended to meet applications. It treats data consistently—the same operators deal with scalars and arrays, or with numbers and characters. Syntax is simple and unambiguous. Further, APL has an unequaled assortment of built-in functions. (See figure 1.)

Figure 1: Common APL Operations

The following is a guide to a small subset of common APL operations. Short examples illustrate how these operations are used in the Life game program.

Four test variables are used in the examples:

V	is	1	3	5	7	(numeric vector)
S	is	5				(numeric scalar)
M	is	1	2	3	4	(2-D numeric matrix)
		5	6	7	8	
		9	10	11	12	
C	is	A	B	C	D	(2-D character matrix)
		E	F	G	H	
		I	J	K	L	

Name	Description	Format	Example
Assignment	Assign value of x to y	y←x	y←S y←V Puts 5 in variable y Puts array 1 3 5 7 in y
Addition		x + y	S + 1 is 6 (scalar+scalar=scalar) V + S is 6 8 10 12 (vector+scalar=vector) V + 1 2 3 4 is 2 5 8 11 (vector+vector=vector)
Subtraction		x − y	
Multiplication		x × y	
Division		x ÷ y	
Logical AND, OR		x ∧ y x ∨ y	1∧1 is 1 (true) 10∨11 is 11 (true true)
Logical NOT		∼x	∼1 is 0 ∼0 is 1
Rotate	Rotate y along *last* axis as specified by x	x ϕ y	1ϕV is 3 5 7 1 −1ϕV is 7 1 3 5 2ϕM is 3 4 1 2 7 8 5 6 11 12 9 10
Rotate	Rotate y along *first* axis as specified by x	x θ y	1θM is 5 6 7 8 9 10 11 12 1 2 3 4
Format	Convert y to character(s)	⍕y	⍕V is 1 3 5 7 (7 characters: 4 digits and 3 spaces)
Quad	Output contents of x to display	⎕←x	⎕←V shows 1 3 5 7 on display
Roll	Give random integer from 1−x	?x	?S gives random integer from 1-5 ?V gives 4 random integers from (1-1) (1-3) (1-5) (1-7)

APL Syntax

APL syntax underscores the simplicity of the language. It requires the user to memorize no precedence rules. In APL, every expression is evaluated right to left, except where grouped by parentheses. Most languages evaluate expressions from left to right and give some operators precedence over others.

For example, in the expression *4+3×2+1=11*, multiplication takes precedence over addition in most languages. In APL the same expression is evaluated right to left as *[(1+2)×3]+4=13*. Multiplication is not done first, unless parentheses are used to alter the evaluation order, as in *4+(3×2)+1=11*.

Why does APL exhibit this nonstandard lack of operator precedence? Because it's simpler. Memorizing the precedence of more than 75 built-in operators is impractical. Since all operators in APL have the same precedence, only parentheses alter the right-to-left evaluation order, and any APL expression is simplified and unambiguous.

APL and Data

No other language gives a programmer control of data the way APL does. One reason is that any APL variable can hold any type of data—numeric or character, scalar or array—at any time. Figure 2 shows how to assign a value to an APL variable. A very similar BASIC expression is also shown. In fact, adding two variables is done in much the same way in BASIC and APL. But the similarity ends when a list (or array) of data must be stored and used—APL is much simpler.

APL handles arrays in the same way it handles single numbers (called scalars). To assign a list of numbers to an APL variable, the programmer simply has to do it—no loops, no fuss. In contrast (as shown in figure 2), BASIC must use a special dimensioned-array variable, and each data value has to be loaded separately into its spot in the array. APL adds two arrays just as it adds two scalars. In fact, a function containing a line that does this may be

Figure 2: APL Versus BASIC Data Handling

Assigning scalar data to variables:

APL	BASIC
NUM 1 ← 4	NUM 1 = 4
NUM 2 ← 2	NUM 2 = 2

Adding scalar variables:

APL	BASIC
SUM ← NUM 1 + NUM 2	SUM = NUM 1 + NUM 2

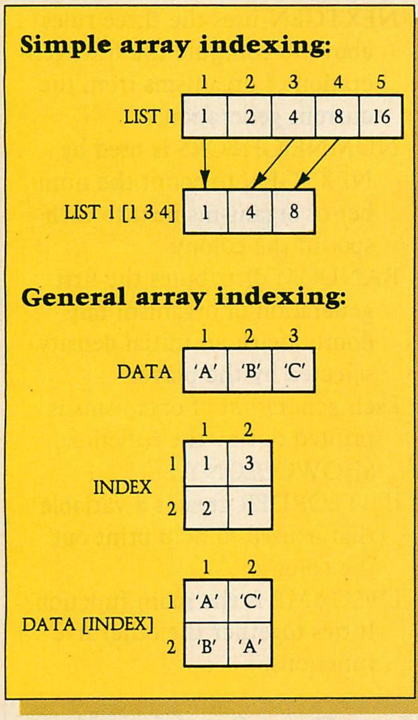
Assigning array data to variables:

APL	BASIC
LIST 1 ← 0 2 4	LIST 1 [1] = 0 : LIST 2 [1] = 4
LIST 2 ← 4 5 6	LIST 1 [2] = 2 : LIST 2 [2] = 5
	LIST 1 [3] = 4 : LIST 2 [3] = 6

Adding array variables:

APL	BASIC
SUMLIST←LIST 1 + LIST 2	For I = 1 to 3 SUMLIST [I] = LIST 1 [I] + LIST 2 [I] Next I

Figure 3: APL Indexing



used with array data one time and with scalar data another time.

Individual elements of an array are accessed in APL just as in BASIC. In figure 3, LIST1 [3] is the third element in a variable LIST1 (which is 4 in the example). APL indexing is much more general, however. Almost any subset of an array can be specified by listing which elements are desired. For example, LIST1 [1 3 4] is an array with three elements: the first, third, and fourth elements of LIST1.

The second example in figure 3 better illustrates APL indexing. DATA is a short string consisting of three characters, "ABC"; INDEX is a 2-by-2 matrix of numbers from 1 to 3. The expression DATA[INDEX] creates a 2-by-2 matrix of characters, with an "A" wherever INDEX is 1, "B" where INDEX is 2, and "C" where INDEX is 3.

Because of its treatment of data, APL is popular with programmers who must deal with large volumes of data. Each time APL works with data, it determines the type of data and behaves appropriately.

Extensible and Interactive

APL's extensible and interactive nature is largely responsible for the popularity of the language. It is extensible because the user's functions actually extend to meet his current needs. When a function is inside the active (memory) workspace, it is part of APL—there is no difference between primitive (built-in) and user-defined functions.

Any APL function can be individually executed by typing its name and any required parameters. For example, in order to calculate *23.4×567.8*, type that expression in. APL will execute it immediately and display the answer, *591.2*. Besides being handy for "calculator-style" computing, this interaction is helpful for developing functions.

When APL is used to develop an algorithm, it can test small sections interactively, using any special test data that are necessary. This allows programs to be created and verified one step at a time. After using this approach a few times, a programmer probably will not want to go back to the testing environment most languages dictate—that is, edit the whole thing, then cross your fingers and watch for smoke.

To help the user with this modular development, APL's debugging facilities can trace or single-step through the functions. This provides a "window" into a function's operation while it executes.

The APL Workspace

APL is not merely a programming language. It is an interactive environment for program development. Figure 4 presents an analogy to the APL environment. A carpenter who builds shelves and tables uses the same workroom for both types of work. He has a separate closet for unfinished shelves and tables, and probably keeps his tools, nails, and finishing supplies in another closet.

In APL a computer's memory is an active workspace that holds both the functions and the data being worked on. Different projects' workspaces can be saved in disk files. Many APL programmers also keep "toolbox" workspaces on disks that hold utility functions to simplify program editing or testing. These disk-based workspaces cannot be worked on directly, but functions and data can be transferred freely between active (memory) and saved (disk file) workspaces.

A programmer may have several ongoing APL projects, with a saved workspace for each. To switch to another project, he can save the current active workspace in a disk file, then copy another project's workspace from disk into a clean, active workspace.

The Game of Life

The best way to get a taste for what APL can do better than other languages is to see it in action. My first APL solo flight was a program to

play the game of Life. Devised by the Cambridge mathematician J.H. Conway, this game simulates a colony of simple organisms in a confined environment. The program is short—about 40 lines long—but demonstrates several important APL features: function declarations, matrix operations, temporary variables, random number generation, string manipulation, row reduction and expansion, and program branching.

The game of Life is very easy. Only three rules control the growth of the colony: (1) an organism will die if it has fewer than two neighbors; (2) an organism will die if it has more than three neighbors; and (3) an organism will be born into an empty spot if that location has exactly three neighboring organisms. The program computes what the next generation of the colony looks like by applying these rules to each location in the colony.

Six functions comprise the Life game program:

NEXTGEN uses the three rules above to compute the next generation of organisms from the current generation.

NUMNEIGHBORS is used by NEXTGEN to count the number of organisms next to each spot in the colony.

RANDOM distributes the first generation of organism randomly, with an initial density selected by the player.

Each generation of organisms is printed out by the function SHOWCOLONY.

INITBORDER creates a variable that is used to help print out the colony.

LIFEGAME is the main function. It ties together the other five functions.

Main Data Structures

The primary data structure in Life is the game board, which is a square matrix. Only one organism can occupy any one spot on the board.

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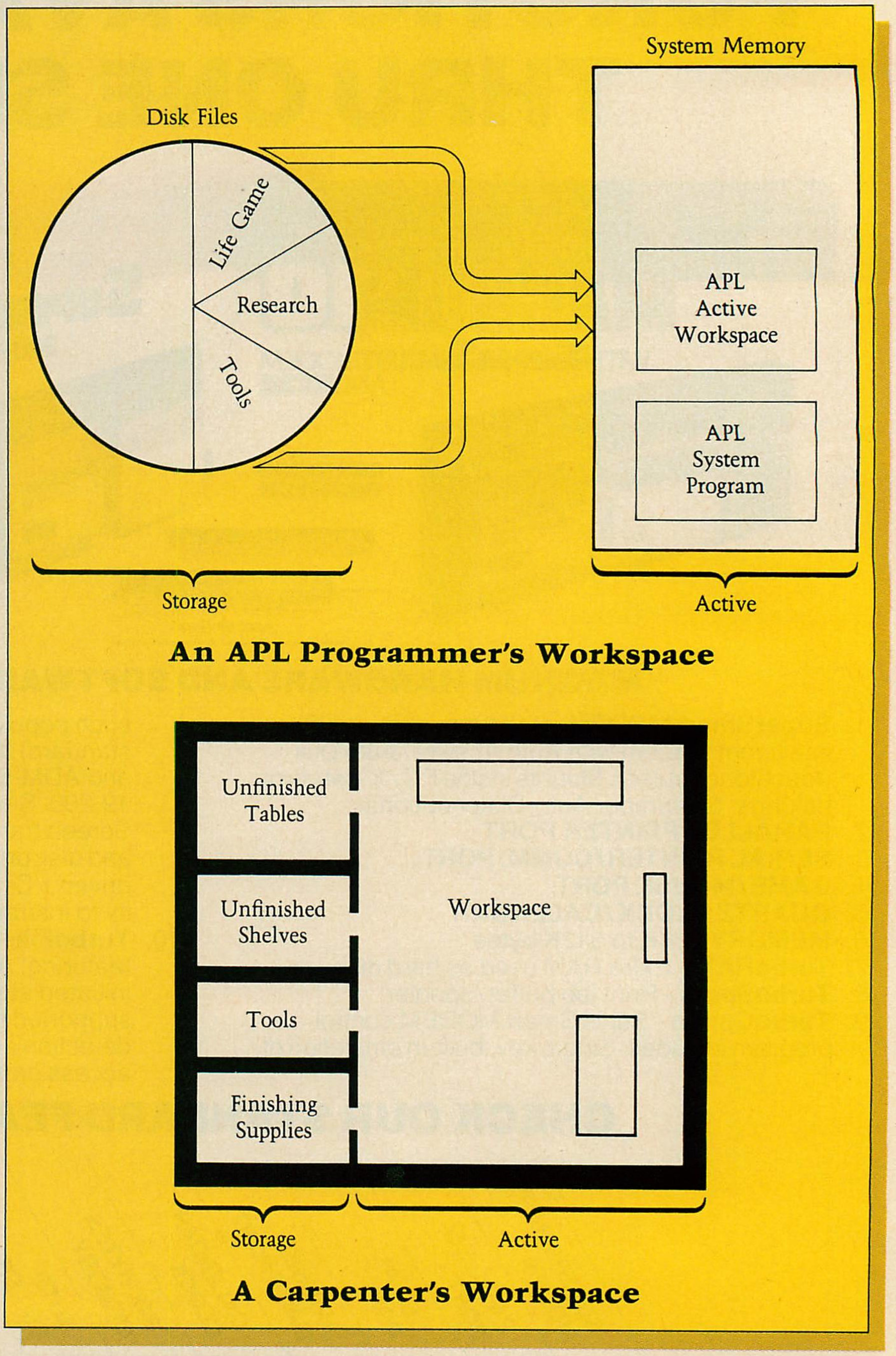
Figure 4: The APL Environment



Each spot has eight adjacent spots, so an organism may have up to eight neighbors. The simplest structure is a matrix with a 1 in every location that has an organism, and a 0 in each empty spot.

The matrix variable, COLONY, is illustrated in figure 5 for a 5-by-5 game board. In that example five organisms in COLONY are denoted by 1s in the matrix. In APL, as in BASIC, the elements of an array are referred to by indexing. For instance, the five organisms in COLONY are located at the coordinates [2;3] (row 2, column 3), [3;3], [3;2], [4;2], and [4;4]. Thus, COLONY [4;4] is an APL expression referring to the organism near the lower right corner of the game board.

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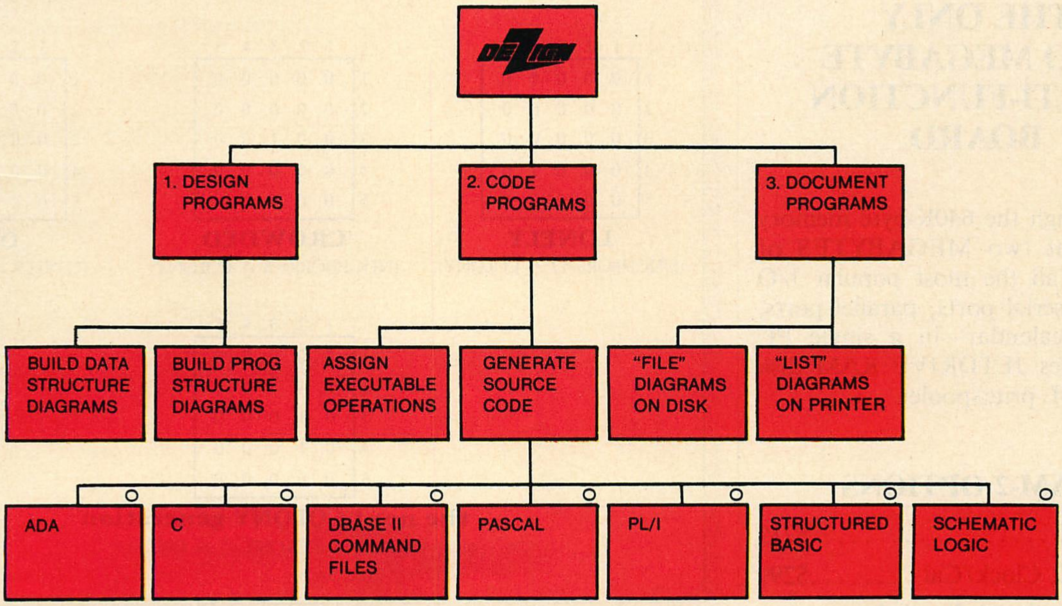

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Figure 5: Life Data Structures

COLONY

row \ column	1	2	3	4	5
1	0	0	0	0	0
2	0	0	1	0	0
3	0	1	1	0	0
4	0	1	0	1	0
5	0	0	0	0	0

NEIGHBORS

	1	2	3	4	5
1	0	1	1	1	0
2	1	3	2	2	0
3	2	3	4	2	0
4	2	2	4	1	0
5	1	1	0	0	0

BORN
(NEIGHBORS=3)

	1	2	3	4	5
1	0	0	0	0	0
2	0	1	0	0	0
3	0	1	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0

LONELY
(NEIGHBORS<2 ∧ COLONY)

	1	2	3	4	5
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	1	0
5	0	0	0	0	0

CROWDED
(NEIGHBORS>3 ∧ COLONY)

	1	2	3	4	5
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	1	0	0
4	0	0	0	0	0
5	0	0	0	0	0

DIED
(LONELY ∨ CROWDED)

	1	2	3	4	5
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	1	0	0
4	0	0	0	1	0
5	0	0	0	0	0

the next COLONY generation
((BORN) ∨ (COLONY ∧ ~ DIED))

	1	2	3	4	5
1	0	0	0	0	0
2	0	1	1	0	0
3	0	1	0	0	0
4	0	1	0	0	0
5	0	0	0	0	0

are used. The variable NEIGHBORS (figure 5) keeps track of how many neighbors each spot on the board has. For example, the location COLONY[2;2] has three adjacent organisms (marked by 1s in locations [2;3], [3;3], and [3;2]). Therefore, NEIGHBORS[2;2] equals 3.

Each spot in COLONY with exactly three neighbors is marked by a 1 in the variable BORN, as in figure 5. This variable is used to enforce the rule that an organism can be born into an empty spot with three neighboring organisms.

LONELY and CROWDED mark the location of each organism that will die because it has fewer than or more than three neighbors. DIED combines LONELY and CROWDED into one matrix.

The NEXTGEN Function

The heart of the Life program is the NEXTGEN function. This function computes what the next generation of COLONY will look like; it is an expression of the three rules of Life that were presented above.

Each line in the NEXTGEN function implements a separate portion of the game rules. APL's simplified array handling lets each line do the work of a half-dozen statements in conventional languages. As soon as a user is familiar with some basic APL symbols and syntax, a function such as NEXTGEN is easy to read and write.

The first line (0) of any APL function is a function declaration. It gives the name of the function, how the function is used, and what (if any) temporary variables are to be created for use by the function.

In figure 6, line 0 of NEXTGEN declares five temporary variables that will exist only while NEXTGEN is executing. These temporary variables are declared by

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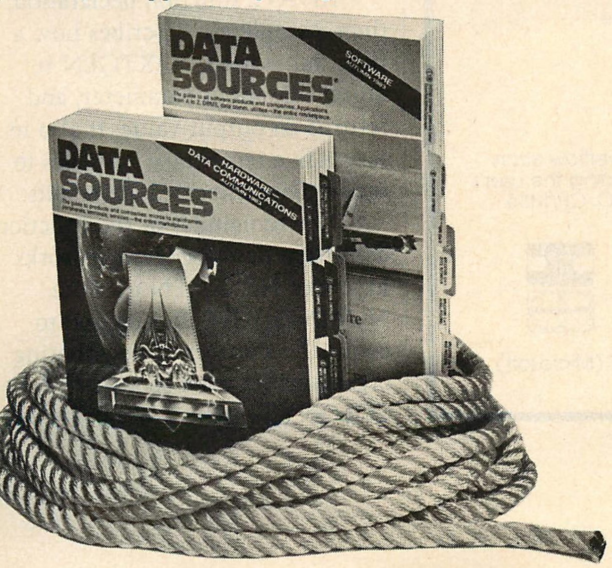

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listing the desired variable names on line 0, preceding each one with a semicolon. These variables hold several intermediate results.

Compare the NEXTGEN function declaration (line 0) in figure 6 to line 8 of the LIFEGAME function in figure 12, where NEXTGEN is actually used. The two lines are similar in form (ignoring the five declared temporary variables). The function declaration provides a template for how the function is used.

In line 8 of LIFEGAME, NEXTGEN is executed with one input parameter, the COLONY game board. It also has an output (the updated game board) that is assigned to another variable (in this example COLONY is used again, but any variable could have been used to "catch" NEXTGEN's output data).

The NEXTGEN function declaration supports this by providing a temporary input variable (called COLONYIN) and a temporary output variable (called COLONYOUT). Whenever NEXTGEN is used, input data (COLONY, in the example) are copied into NEXTGEN's temporary input variable. When the function ends, whatever is in the temporary output variable is automatically assigned to the indicated variable (COLONY in line 8 of LIFEGAME).

NEXTGEN does not care what the name of the original input data is, or where the data came from. NEXTGEN can thus be used in several places with different variables.

An APL function declaration, then, completely describes how a function is used. NEXTGEN requires one input parameter, and returns an output value. It also reserves five temporary variables to accumulate intermediate results.

The remainder of the function definition describes how it works. Line 1 of NEXTGEN uses the NUMNEIGHBORS function to count the number of neighboring organisms for each spot in COLONYIN (which is a copy of the

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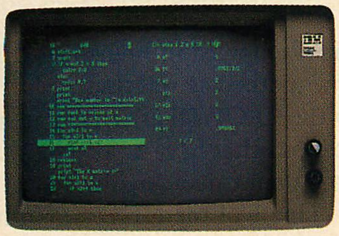

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Figure 6: NEXTGEN

```
[   0] COLONYOUT ← NEXTGEN COLONYIN ;NEIGHBORS
                 ;BORN ;LONELY ;CROWDED ;DIED
[   1] NEIGHBORS ← NUMNEIGHBORS COLONYIN
[   2] BORN      ← NEIGHBORS = 3
[   3] LONELY    ← COLONYIN ^ NEIGHBORS < 2
[   4] CROWDED   ← COLONYIN ^ NEIGHBORS > 3
[   5] DIED      ← LONELY ∨ CROWDED
[   6] COLONYOUT ← BORN ∨ COLONYIN ^ ~DIED
```

Figure 7: NUMNEIGHBORS

```
[   0] TEMPOUT ← NUMNEIGHBORS TEMPIN
[   1] TEMPOUT ← 1 ⌽ 1 ⊖ TEMPIN
[   2] TEMPOUT ← TEMPOUT + 1 ⊖ TEMPIN
[   3] TEMPOUT ← TEMPOUT + ¯1 ⌽ 1 ⊖ TEMPIN
[   4] TEMPOUT ← TEMPOUT + ¯1 ⌽ TEMPIN
[   5] TEMPOUT ← TEMPOUT + ¯1 ⌽ ¯1 ⊖ TEMPIN
[   6] TEMPOUT ← TEMPOUT + ¯1 ⊖ TEMPIN
[   7] TEMPOUT ← TEMPOUT + 1 ⌽ ¯1 ⊖ TEMPIN
[   8] TEMPOUT ← TEMPOUT + 1 ⌽ TEMPIN
```

Figure 8: RANDOM

```
[   0] RANDOM
[   1] COLONY ← (? (SIZE,SIZE) ⍴ 100) ≤ DENSITY
```

Figure 9: SHOWCOLONY

```
[   0] SHOWCOLONY ; CHARINDEX ; CHAROUT
[   1] CHARINDEX ← BORDERMASK + COLONY + 1
[   2] CHAROUT   ← 'X O' [ CHARINDEX ]
[   3] ((SIZE × 2) ⍴ 0 1) \ CHAROUT
[   4] ⎕ ← 'GENERATION NUMBER:  ', ⍕GENERATION
[   5] ⎕ ← 'CURRENT POPULATION: ', ⍕POPULATION
[   6] ⎕ ← ''
[   7] ⎕ ← ''
```

COLONY game board) and puts the resulting matrix in the temporary variable NEIGHBORS. In figure 5, COLONY[2;2] has three neighboring organisms, so NEIGHBORS [2;2] is equal to 3.

Line 2 of NEXTGEN puts a 1 in each location of BORN corresponding to a COLONYIN spot with exactly three neighboring organisms. BORN can thus be used to enforce the Life game rule that an organism will be born into an empty spot if that location has exactly three neighboring organisms.

The APL expression NEIGHBORS=3 produces a matrix the same size as NEIGHBORS. Where NEIGHBORS equals 3, the expression is true, and a 1 is put in that location in the matrix. Where NEIGHBORS does not equal 3, the expression is false, so a 0 is put in the matrix. This matrix is stored in the BORN variable (see figure 5).

Notice that the expression in line 2 performed a logical operation on every location of an arbitrarily sized matrix. This economy of expression is unique to APL.

The Life rule that an organism will die if it has fewer than two neighbors is enforced in a similar way by line 3 of NEXTGEN. As illustrated in figure 5, the variable LONELY marks the location of each organism that will die. The expression NEIGHBORS<2 does most of the work by marking each location in COLONYIN that has fewer than two neighboring organisms.

> *The NEXTGEN function demonstrates how easily (and automatically) APL handles matrix data. The user never has to be concerned with the size or shape of a matrix.*

When NEIGHBORS<2 is ANDed with COLONYIN, only those board locations with fewer than two neighbors and with an organism present are marked. This works because of the data structure that is chosen for the game board COLONY: locations with an organism present have a 1, empty spots hold a 0. A logical AND puts a 1 in LONELY where both COLONYIN and NEIGHBORS<2 are 1.

The rule that an organism will die if it has more than three neighbors is enforced in line 4 using the same method as was used in line 3—the CROWDED variable marks locations that have an organism and more than three neighbors.

Line 5 of the NEXTGEN function marks each organism in COLONYIN that will expire. That is, a logical OR operation allows the variable DIED to mark each location where an organism is either LONELY or CROWDED.

The last line of the NEXTGEN function updates COLONYOUT to the next generation of organisms. The next COLONY generation is depicted in figure 5.

The NEXTGEN function demonstrates how easily (and automatically) APL handles matrix data. The user never has to be concerned with the size or shape of a particular matrix. To find exactly which locations in a matrix are greater than two, a simple expression like MATRIX>2 is sufficient.

The NUMNEIGHBORS Function

NUMNEIGHBORS uses two simple but powerful matrix rotate operations to perform some elementary "signal processing" on the game board. The NEXTGEN function

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uses NUMNEIGHBORS to compute the number of organisms adjacent to each location in COLONYIN. As figure 7 shows, line 0 in NUMNEIGHBORS copies the game board in COLONYIN into a temporary input variable called TEMPIN; it returns an output value (to NEIGHBORS) via the TEMPOUT (temporary output) variable. No other temporary variables are used.

One way to write NUMNEIGHBORS is to examine each spot in TEMPIN individually and count the number of 1s (organisms) in the eight adjacent spots. This works, but there is a simpler way to approach the problem. Every organism (marked in TEMPIN with a 1) has eight adjacent locations. If we add 1s to the eight locations adjacent to each organism in TEMPIN, the result is the same as the original suggestion: every spot with *n* adjacent organisms holds the number *n*.

The 1s can be added to the TEMPIN variable using two APL rotate operators (refer to figure 1). Line 1 of NUMNEIGHBORS temporarily shifts TEMPIN (a copy of COLONYIN, which is NEXTGEN's copy of the COLONY board) up one row and left one column, and stores this matrix in TEMPOUT. This procedure puts a 1 in each location that is up and to the left of an organism. Line 2 temporarily shifts TEMPIN up one row and adds this to the previous TEMPOUT matrix. For each organism on the board (TEMPIN), a 1 has been added to the two locations: up one and left one; and up one. For each empty spot on the game board, 0s have been harmlessly added to the same two relative locations since empty spots are represented by 0s.

Lines 3 through 8 of NUMNEIGHBORS repeat this process for the remaining six locations adjacent to each organism. When NUMNEIGHBORS finishes, each organism has added a 1 to each of its eight adjacent spots. The final

Figure 10: Printing COLONY

	1	2	3	4	5
1	0	0	0	0	0
2	0	0	1	0	0
3	0	1	1	0	0
4	0	1	0	1	0
5	0	0	0	0	0

COLONY

	1	2	3	4	5
1	0	0	0	0	0
2	0	1	1	1	0
3	0	1	1	1	0
4	0	1	1	1	0
5	0	0	0	0	0

BORDERMASK

	1	2	3	4	5
1	1	1	1	1	1
2	1	2	3	2	1
3	1	3	3	2	1
4	1	3	2	3	1
5	1	1	1	1	1

CHARINDEX
(COLONY + BORDERMASK + 1)

	1	2	3	4	5
1	X	X	X	X	X
2	X		0		X
3	X	0	0		X
4	X	0		0	X
5	X	X	X	X	X

CHAROUT
'X 0' [CHARINDEX]

Figure: 11: INITBORDER

```
[  0]  INITBORDER
[  1]  BORDERMASK ← (SIZE,SIZE) ⍴ 1
[  2]  BORDERMASK [ 1,SIZE ; ] ← 0
[  3]  BORDERMASK [ ; 1,SIZE ] ← 0
```

Figure 12: LIFEGAME

```
[  0]  LIFEGAME
[  1]  INITBORDER
[  2]  RANDOM
[  3]  COLONY ← COLONY ^ BORDERMASK
[  4]  POPULATION ← +/ ,COLONY
[  5]  GENERATION ← 1
[  6]  LOOP: →END × ⍳POPULATION = 0
[  7]      SHOWCOLONY
[  8]      COLONY ← NEXTGEN COLONY
[  9]      GENERATION ← GENERATION + 1
[ 10]      COLONY ← COLONY ^ BORDERMASK
[ 11]      POPULATION ← +/ ,COLONY
[ 12]  →LOOP
[ 13]  END: ⎕ ← 'ALL ORGANISMS EXTINCT!'
[ 14]  ⎕ ← 'Goodbye.'
```

count, stored in the temporary output matrix TEMPOUT, is assigned to NEIGHBORS in line 1 of the NEXTGEN function.

The RANDOM Function

RANDOM demonstrates APL's simple facilities for random number generation. For small game boards, such as those in figure 5, a Life program user could create his own initial COLONY matrix. However, Life is most interesting with a board measuring 15 by 15 or larger—even though typing in 225 matrix elements is somewhat tedious.

The RANDOM function will scatter organisms randomly throughout COLONY. A user has some control over how COLONY starts off, since he uses the DENSITY variable to select the approximate initial percentage of occupied COLONY locations. If the user selects an initial population density that is too low (5 percent) the organisms are spread thinly, and they rapidly die out because they have

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fewer than two neighbors. If the initial population is too dense (50 percent or more), massive initial overcrowding thins the organisms quickly. Initial densities from 15 to 30 percent seem to fare best.

Although RANDOM (figure 8) is only one line in APL, the core expression, SIZE, SIZE ρ 100, creates a matrix with SIZE rows and SIZE columns, with the value 100 in each location. When the ? operator, called *roll*, is applied to this matrix, it replaces each 100 with a random number from 1 to 100 inclusive.

Each element of this new matrix (which is now filled with random numbers from 1 to 100) is compared to the global variable DENSITY, a scalar value of 1 to 100. The COLONY matrix is created with a 1 in every location in which the random number was less than or equal to DENSITY, and a 0 in every other spot. For a low DENSITY value like 5, about 5 percent of the random numbers will be less than or equal to DENSITY, so about 5 percent of COLONY elements will be 1s.

The SHOWCOLONY Function

The SHOWCOLONY function (figure 9) introduces APL character handling and provides an example of the language's powerful array indexing. To display the successive generations of COLONY, the user could just print out the variable COLONY. However, the resulting pattern of 1s and 0s would be a bit overwhelming. SHOWCOLONY is used to transform COLONY to the CHAROUT format shown in figure 10. Three characters are used in the print-out: an X for the colony borders, a space for empty spots, and the letter O for organisms.

SHOWCOLONY can be fit on two or three lines if no temporary variables are used, but the resulting definition is rather obscure. The temporary variables CHARINDEX and CHAROUT are introduced to

Figure 13: A Sample Run of the LIFEGAME Program

```
⍝          A Sample run of the Life Game Program

⍝ <--  NOTE: this symbol starts an APL comment: anything
⍝            typed after it is ignored by APL.

⍝               +++++   INSTRUCTIONS   +++++

⍝         1.   Assign the size of the game board to SIZE.
⍝         2.   Assign a density from 1 to 100 to DENSITY.
⍝         3.   Type LIFEGAME ...

⍝               +++++      EXAMPLE:    +++++
SIZE ← 20
DENSITY ← 5
LIFEGAME
  X X X X X X X X X X X X X X X X X X X X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X               O     O               X
  X               O O O O               X
  X             O         O             X
  X             O   O O   O             X
  X             O         O             X
  X               O O O O               X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X X X X X X X X X X X X X X X X X X X X
GENERATION NUMBER:  1
CURRENT POPULATION: 18

  X X X X X X X X X X X X X X X X X X X X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X               O     O               X
  X             O O O O O O             X
  X             O         O             X
  X           O O         O O           X
  X             O         O             X
  X               O O O O               X
  X                 O O                 X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X X X X X X X X X X X X X X X X X X X X
GENERATION NUMBER:  2
CURRENT POPULATION: 22

  X X X X X X X X X X X X X X X X X X X X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X             O O     O O             X
  X             O   O O   O             X
  X                 O O                 X
  X           O O O     O O O           X
  X           O O   O O   O O           X
  X               O     O               X
  X               O     O               X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X X X X X X X X X X X X X X X X X X X X
GENERATION NUMBER:  3
CURRENT POPULATION: 26

  X X X X X X X X X X X X X X X X X X X X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X             O O O O O O             X
  X             O         O             X
  X           O             O           X
  X           O             O           X
  X           O     O O     O           X
  X               O     O               X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X X X X X X X X X X X X X X X X X X X X
GENERATION NUMBER:  4
CURRENT POPULATION: 18

  X X X X X X X X X X X X X X X X X X X X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X               O O O O               X
  X             O O O O O O             X
  X           O O   O O   O O           X
  X           O O         O O           X
  X         O O O         O O O         X
  X             O   O O   O             X
  X                 O O                 X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X X X X X X X X X X X X X X X X X X X X
GENERATION NUMBER:  5
CURRENT POPULATION: 32

  X X X X X X X X X X X X X X X X X X X X
  X                                     X
  X                                     X
  X                                     X
  X                 O O                 X
  X             O         O             X
  X           O             O           X
  X                                     X
  X                                     X
  X         O                 O         X
  X             O   O O   O             X
  X               O O O O               X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X X X X X X X X X X X X X X X X X X X X
GENERATION NUMBER:  6
CURRENT POPULATION: 16

  X X X X X X X X X X X X X X X X X X X X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X               O     O               X
  X                 O O                 X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X X X X X X X X X X X X X X X X X X X X
GENERATION NUMBER:  7
CURRENT POPULATION: 4

  X X X X X X X X X X X X X X X X X X X X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                 O O                 X
  X                 O O                 X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X                                     X
  X X X X X X X X X X X X X X X X X X X X
GENERATION NUMBER:  8
CURRENT POPULATION: 4
```

Figure 14: Modified RANDOM Function

```
[  0] RANDOM
[  1] ⍝  create a 20×20 matrix of 0's
[  2] COLONY ← 20 20 ⍴ 0
[  3] ⍝
[  4] ⍝   put 1's in COLONY to define Cheshire
[  5] ⍝              Cat pattern
[  6] COLONY [ 7 ; 9 12 ] ← 1
[  7] COLONY [ 8 ; 9 10 11 12 ] ← 1
[  8] COLONY [ 9 10 11 ; 8 ] ← 1
[  9] COLONY [ 9 10 11 ; 13 ] ← 1
[ 10] COLONY [ 12 ; 9 10 11 12 ] ← 1
[ 11] COLONY [ 10 ; 10 11 ] ← 1
```

help logically separate subtasks within the function. It is wise to do this whenever a function definition starts to look a little complex.

The function declaration for SHOWCOLONY is simpler than for NEXTGEN, NUMNEIGHBORS, and RANDOM. It has no input parameter, and no output value is returned. SHOWCOLONY takes its input directly from COLONY and displays its output on the screen.

The rightmost expression in line 1 of SHOWCOLONY (figure 9) adds 1 to every location in COLONY, so an organism is represented by a 2, and a blank spot by a 1. This intermediate result is added to BORDERMASK (which the function INITBORDER creates with 0s around the outer edges, and 1s inside, as discussed below). The result of line 1 is a matrix (stored in CHARINDEX) that has a 1 in every border location, a 2 in each empty spot, and a 3 for each organism.

Line 2 of SHOWCOLONY uses APL's powerful array indexing. Since CHARINDEX is a COLONY-sized matrix with values ranging from 1 (border) to 3 (organism), the dummy variable CHAROUT will be assigned a COLONY-sized matrix with an X in each location where CHARINDEX = 1, a space wherever CHARINDEX = 2, and an O wherever CHARINDEX = 3.

A display of CHAROUT would look a little cramped. Line 3 of the SHOWCOLONY function uses the expansion operator \ to spread out CHAROUT when it is printed. The leftmost expression creates a row of alternating 0s and 1s that is twice as wide as COLONY. The expansion operator uses this as a template to form a new character matrix: in each row of CHAROUT, an extra blank is inserted for each 0 in the template, and a character in CHAROUT is inserted for each 1. This expanded version is printed by assigning it to the quad function.

Lines 4 and 5 print out strings indicating the current generation number and population count. Format and concatenate operators are used to convert the numeric GENERATION and POPULATION variables into strings and to add them to the end of the message strings. These arrays are assigned to the quad function for printing.

SHOWCOLONY's last two lines (6 and 7) print two blank lines by assigning an empty string to quad.

The INITBORDER Function

INITBORDER creates a matrix filled with 1s except for a ring of 0s around the outer border. This matrix is used by SHOWCOLONY and LIFEGAME. Line 1 of INITBORDER (figure 11) creates a square matrix with SIZE rows and columns called BORDERMASK (figure 10). The matrix is initialized to all 1s. SIZE is a global variable that holds the size of the COLONY matrix.

Lines 2 and 3 put 0s in the first and last rows and columns of BORDERMASK. BORDERMASK[1 SIZE ;] in line 2 refers to every element in rows 1 and SIZE—when no column numbers are specified every column is assumed. So line 2 puts 0s in rows 1 and SIZE. Line 3 puts 0s in columns 1 and SIZE. BORDERMASK is thus a matrix the same size as the game board fitted with 1s except for a ring of 0s along the outer edge.

SHOWCOLONY uses BORDERMASK to help print out the border area of the COLONY game board with a special character. Another function, LIFEGAME, uses BORDERMASK to sterilize the outer border of the COLONY game board by ANDing these two variables. This prevents organisms from getting to the edge of the game board.

The LIFEGAME Function

The LIFEGAME function controls the overall Life simulation (see figure 12). Line 1 uses the function INITBORDER to create the BORDERMASK variable used in SHOWCOLONY and later in LIFEGAME. In line 2, RANDOM is used to create the COLONY matrix and to (randomly) initialize it to the first generation of organisms. Line 3 uses BORDERMASK to sterilize the outer border of COLONY.

The total number of organisms in this first generation is tallied in line 4. The expression COLONY unravels COLONY from matrix form into one long row of 1s and 0s. The expression +/,COLONY (called a row reduction) adds the 1s and 0s in the unraveled COLONY row. This organism count is put into POPULATION.

The current colony GENERATION number is initialized to 1 in line 5. Line 6 is an APL branch statement. It is read: "This line is labeled 'LOOP'. Go to the line labeled 'END' if POPULATION = 0." That is, when all organisms are dead, the program will branch to the statement labeled END (line 13).

SHOWCOLONY displays the current COLONY in line 7, then computes the next generation of the colony in line 8 using the NEXTGEN function. GENERATION is incremented to indicate the current generation number in line 9.

Casual or Serious: Which APL System to Choose

I have used two APL systems for the IBM PC: the recently released IBM package (which I own) and the STSC version. Based upon reviews published in the past several months and based upon my own experience, I recommend the IBM package for the casual APL user and STSC's APL for the enthusiast.

Although the STSC APL system costs three times more than IBM's $195, the IBM system requires the 8087 Math Coprocessor. This additional purchase will effectively raise the price of the IBM package by $200 to $250.

IBM's APL uses a color graphics adapter so special APL symbols can be displayed with no special hardware. It can use the monochrome adapter as well, but will not correctly display all of the APL symbols. The STSC system works with either display adapter, but requires a special APL character ROM. This makes for a more readable display using APL, but the screen may look strange with other software, since APL symbols will be substituted for certain characters in the original (replaced) IBM ROM.

Several auxiliary software modules extend the IBM APL system to allow file handling, display management, music generation, and full-screen function editing. STSC has a few extension packages as well.

IBM's APL is especially lacking in two areas: printer support and memory management. The IBM package will print the complete APL character set only on an IBM graphics printer. I have an Epson FX-80, which almost does the trick, but a few characters don't print correctly. Perhaps some clever programmers will come up with special APL printer software in the near future.

My second complaint with the IBM package is its stinginess with memory. My PC has 512K of memory, but the APL active workspace is still limited to 64K. This inadequate memory management restricts programmers with even moderate amounts of data. Remaining memory forms an "elastic" workspace that can hold functions and data not immediately required. APL automatically (and slowly) swaps objects between the 64K active workspace where all calculations take place and this elastic workspace reservoir, but with a noticeable time penalty.

The STSC package suffers from neither lack of printer support nor inadequate memory.

The lower-priced IBM APL package is clearly intended for a casual user, such as an engineer or business person who needs inexpensive access to an APL system with moderate capability. A PC dedicated to more serious engineering, business, or educational applications would be better equipped with the STSC's APL package than with IBM's.

—Pardner Wynn

Like lines 3 and 4, lines 10 and 11 of LIFEGAME sterilize the colony border before counting the number of organisms present. Line 12 is a jump to line 6 (labeled LOOP), which is done to repeat the display and update functions in lines 7 through 11 until the organisms are dead. A brief termination message is printed in line 13, followed by another one in line 14.

The Life Program

Before running the Life program, the user should select the desired size of the COLONY game board and assign it to SIZE. A value of 15 will create a 15-by-15 matrix for COLONY. The DENSITY variable should be set to any number from 1 to 100 (15 to 30 for best results). Typing LIFEGAME will start the simulation. Figure 13 shows LIFEGAME being run on IBM's APL.

The colony of organisms alternately expands and contracts in fascinating patterns. The program prints successive generations on the computer display until no organisms remain. In some cases the colony never dies out, so the program continues to execute until the user presses the APL INTERRUPT key (the Escape key in IBM's APL).

Although the random patterns produced by the original RANDOM function are interesting, the user may want to define his own patterns. To do this, modify RANDOM to create COLONY with any size and any pattern of 1s and 0s. The sample session of figure 13 was run with a modified version of the RANDOM function, which assigns COLONY a pattern of 18 organisms called the Cheshire Cat (see figure 14). This pattern fades away in generations 2 through 6, leaving a smile in generation 7 and a paw print in generation 8.

Using APL

Three generalizations about the Life program point out APL's usefulness in a wide variety of programming applications. First, Life's simple data structures allow use of APL's powerful array manipulation facilities. Few languages support data structures as well as APL. Second, an APL expression or operation applied to matrix data automatically applies to the entire matrix—whatever its size. Finally, by dividing the program into several smaller modules the user can concentrate on one programming task at a time. APL supports this modularity with flexible function declarations and use of temporary variables.

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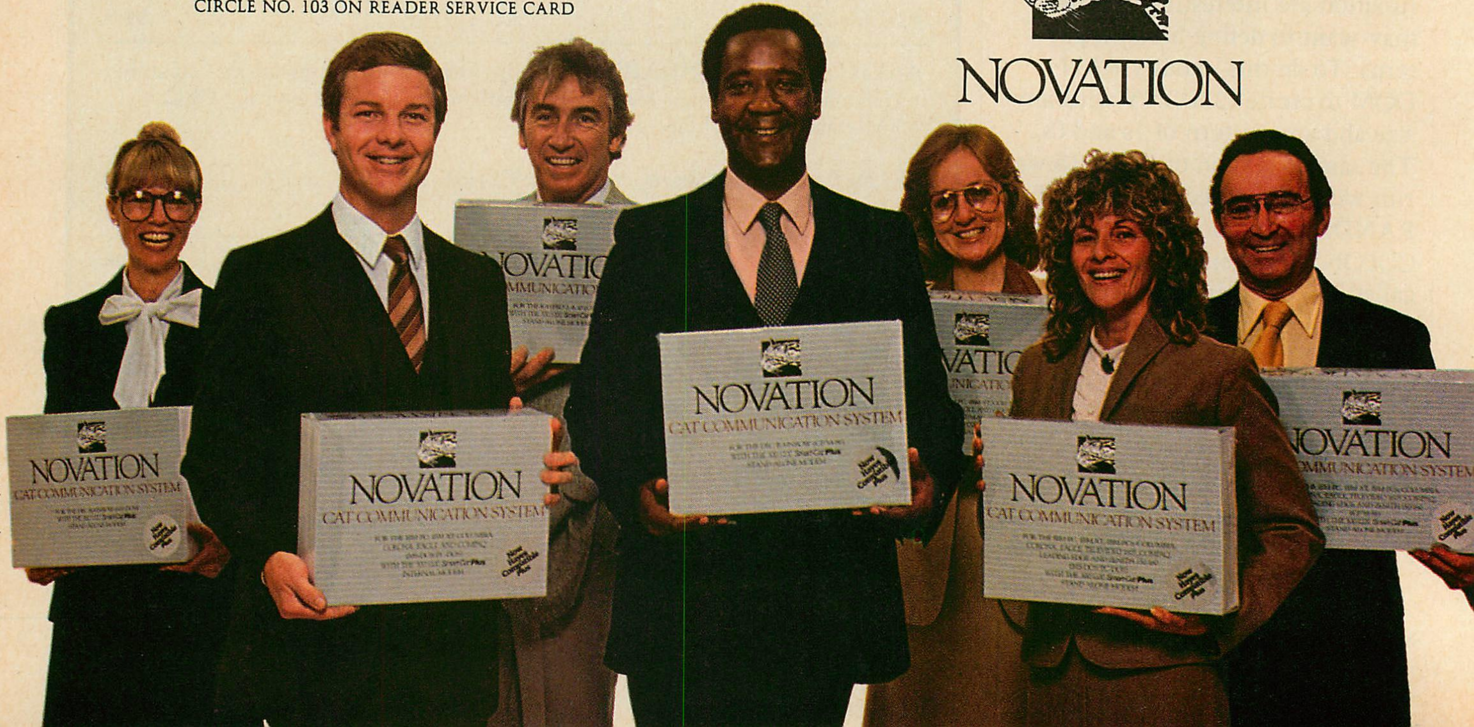

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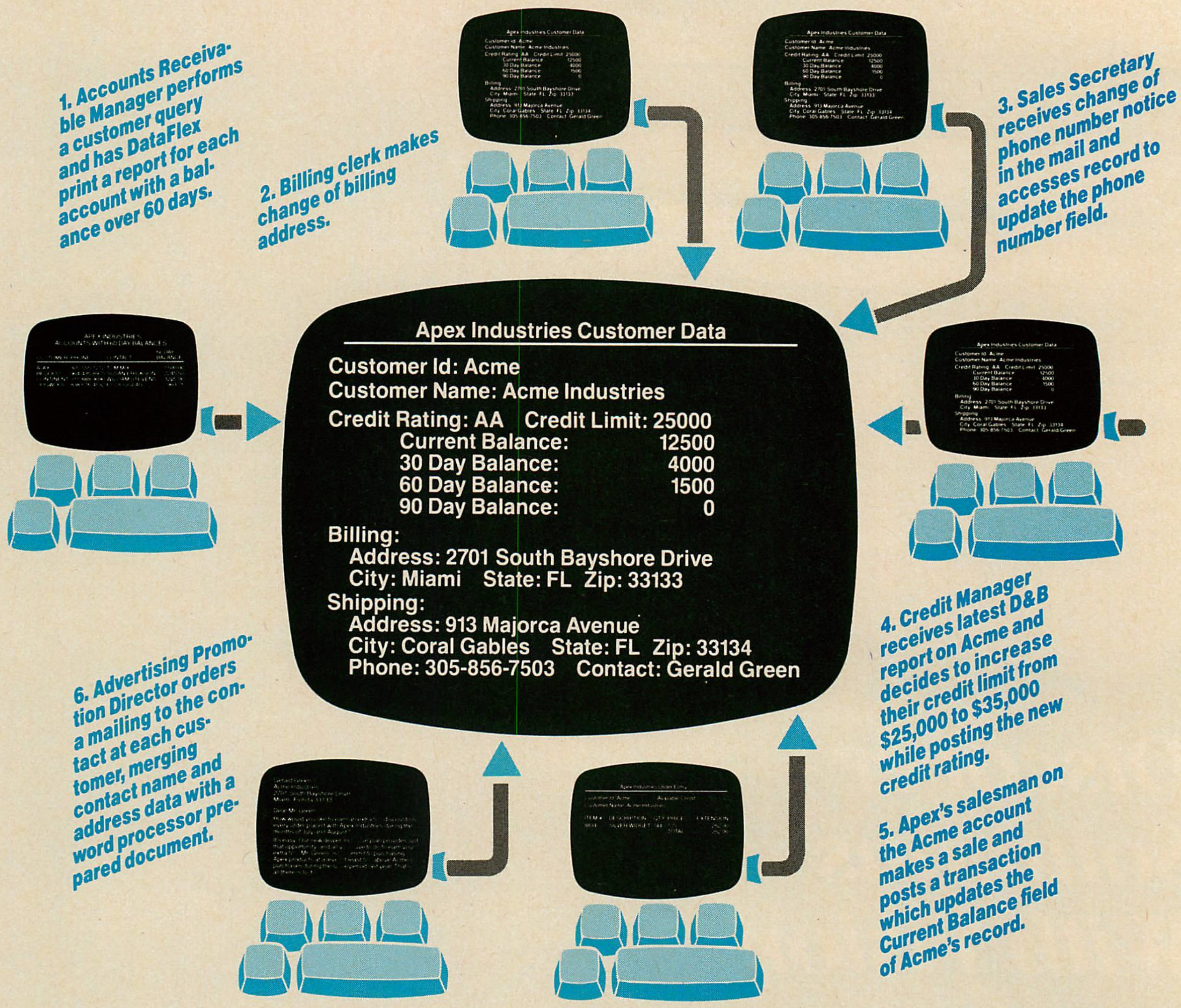

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GREGG L. PETTIT

The BEST of Both WORLDS

Macros that give the programmer access to the power of assembly language and the convenience of structured programming

Assembly language is a powerful and useful tool; it can make a computer do anything within that computer's capability. The language does have drawbacks, however. For example, many instructions have to be written to accomplish what might be considered a single function. These drawbacks led to the development of more convenient higher-level languages in which a single statement can represent many assembly language instructions.

Some languages were developed for specific purposes, as COBOL was for business data processing and FORTRAN for statistical/engineering purposes. Other languages, such as PL/1, were developed for general purposes. In the hands of expert programmers these languages provide excellent solutions to a wide class of problems. However, for developing utilities, general-purpose programs, interactive graphic games, etc., assembly language is probably still the best choice because of its access to the full range of the computer's capabilities.

Another reason for choosing one of the "higher-level circus animals" rather than assembly language is that most higher-level languages provide the logical structures needed for structured programming, while assembly languages traditionally do not. One of the ways this objection can be overcome is through the use of a well-designed set of macros that provides the kind of control structures that are found in higher-level languages.

In our data processing shop we use a set of macros that provides structured programming capability for the IBM/370 assembly language. Having found these macros advantageous, I set out to implement the IF and the DO sets for use with the PC Macro Assembler.

(Note: The names of the macros in the IF macro set for the PC are suffixed with an M because the PC Macro Assembler reserves the IF, ELSE, and ENDIF as conditional pseudo-ops. The conditional pseudo-op IF gives the PC Macro Assembler the capability to determine whether

Gregg L. Pettit is a data processing programmer writing general-purpose software for Harry and David Company, a subsidiary of Bear Creek Corporation, located in Medford, Oregon.

Figure 1: Example of Flag Setting and Testing Instructions

```
        CMP   CL,0          ;Compare the CL register to 0
        JE    LAB1          ;Test Flag Register
              .             ;If the CL register was not
              .             ;equal to 0 execution continues
        Assembly            ;with these instructions.
        instructions
        for CL not
        equal to 0
              .
        JMP   LAB2          ;Jump unconditionally to LAB2

LAB1:         .             ;Execution continues here if the
        Assembly            ;CL register was equal to 0.
        instructions
        for CL equal
        to 0
              .
LAB2:
```

Figure 2: Example of Logic Provided by a DO WHILE and ENDDO Combination

```
        DO WHILE,CMP,DL,E,0

+?DW1:
+           CMP   CL,0
+           JE    ?DL1
+           JMP   ?DE1
+?DL1:            .
              Assembler
              Instructions
              for CL equal to
              zero.
                  .
        ENDDO
+             JMP   ?DW1
+?DE1:
```

source code contained within the pseudo-op and its ENDIF is to be assembled based on the truth value of some expression.)

FLAG SETTING AND TESTING

The architecture of computers today provides two classes of instructions by which the logic of an assembly language program is accomplished. Instructions in the first class set some indicator that signals the result of its execution. Those in the second class test the indicator that was set by the first class. Based on the result of that test, execution either continues with the next sequential instruction or is transferred to some other instruction.

The indicator provided by the 8088 CPU is called the flags register. This register contains 12 flags or bits, some of which are set on or off by the result of actions by the first class of instructions. Some examples of these flag-setting instructions are the compare instruction (CMP), an arithmetical instruction such as subtract (SUB), etc.

The 8088 CPU also provides the second class of instructions, such as Jump Equal (JE), Jump Not Equal (JNE), and Jump If Above or Equal (JAE), which tests the current status of the flags register and transfers execution to another instruction—that is, execution jumps to another instruction if the condition is true. The logic of an assembly language program is accomplished through a combination of flag-setting and flag-testing instructions (see figure 1).

ADVANTAGES OF MACROS

One of the most important advantages gained in using the macros for structured programming is that the programmer need not explicitly code the jump statements and their destination labels; the PC macros for structured programming provide this control implicitly. For instance, each macro set contains a header macro (IFM or DO) that generates a jump on the condition desired to the instructions to be executed for that condition. If the necessary condition is not met by the flags register at the time the jump on condition is executed, the following unconditional JMP (also generated by the header macro) jumps to the trailer macro (ELSM, ENDIFM, or ENDDO). See figure 2 for the kind of logic provided by a DO WHILE, ENDDO combination. The statements in figure 2 that begin with a "+" were generated by the Macro Assembler from the DO WHILE, ENDDO macros. For further examples of the logic generated by IFM and DO macro sets, see table 1.

Coding time can be shortened by removing the time-consuming chore of inventing meaningful labels or keeping track of the function of non-meaningful labels. Another way to reduce coding time is by removing the possibility of misspelling labels or branching to the wrong label. For those who like to put their routines into flow charts, further gains in efficiency can be made by using decision paths that correspond to the structured programming macros. These macros can then be coded to follow the flow chart and give the logical structure on which to hang the details of the code later. Following this procedure will increase the likelihood of getting the logic of the routine correct from the start and thus will decrease debugging time.

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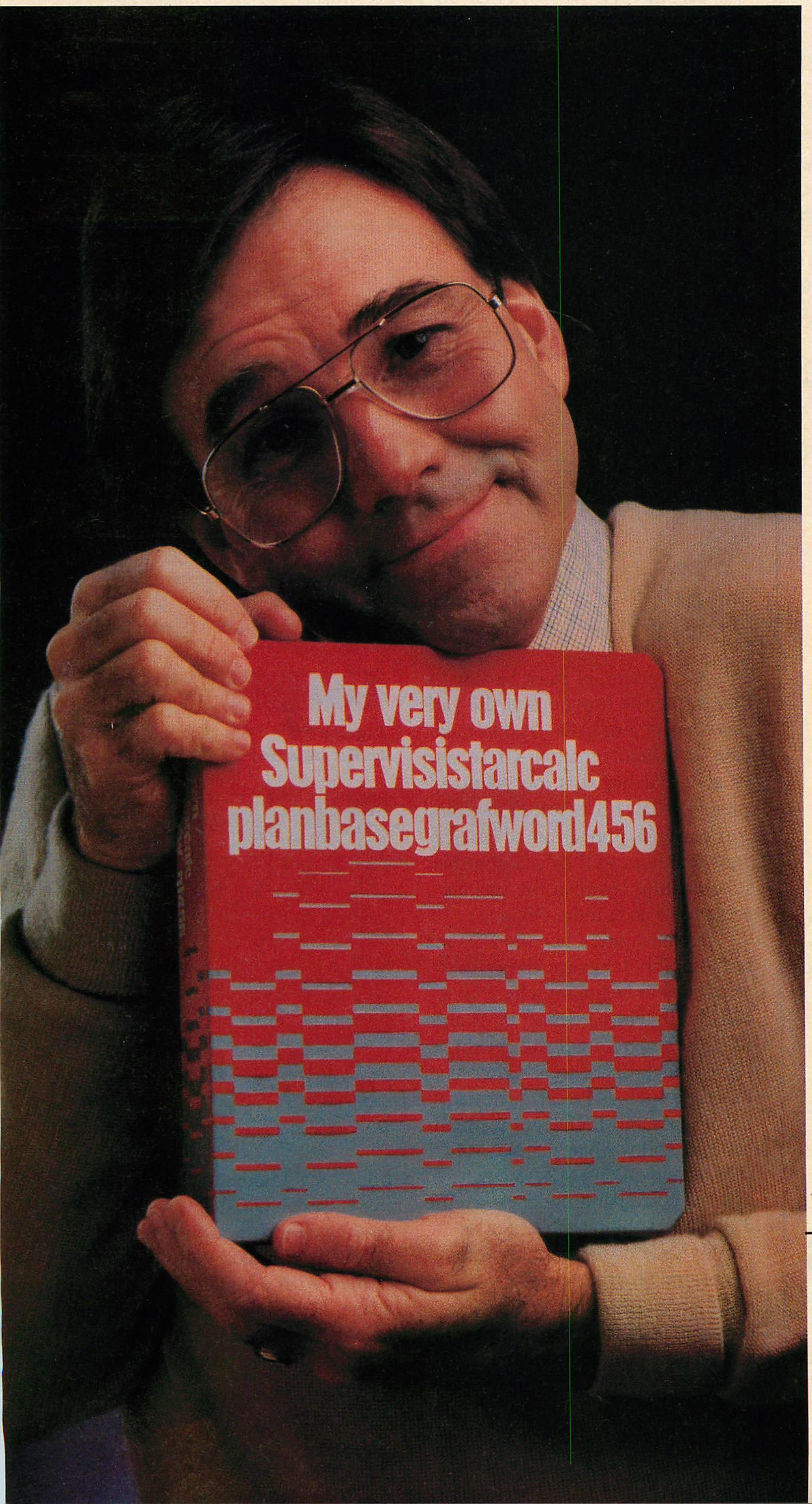

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Figure 3: An Illustration of the Readability of Assembly Language Code Using the Macros for Structured Programming

```
 Without Using Macros                              Using Macros
----------------------                           ----------------

          CMP   DL,0                             IFM CMP,DL,E,0
          JNE   LBLNE1                               IFM CMP,CL,E,0
          CMP   CL,0                                     .
          JNE   LBLNE2                                   code A
                .                                        .
                code A                               ELSEM
                .                                        .
          JMP   FINIEQ                                   code B
LBLNE2:                                                  .
                .                                    ENDIFM
                code B                           ELSEM
                .                                    .
          JMP   FINIEQ                               code C
LBLNE1:                                              .
                .                                ENDIFM
                code C
                .
FINIEQ:
```

A programmer must be able to determine the functions of the various parts of a routine—not to mention its overall function—if he is to be able to debug that routine or modify it later. Structured programming macros provide an advantage in this area as well by making the relationships between the various sections of code more obvious.

Furthermore, since the PC's macro assembly language allows instructions to begin anywhere on a line, by indenting nested IFMs and DOs the programmer can get the same readability as in a higher-level language such as Pascal. A nested set of IFMs and ENDIFMs is much easier to follow than many CMPs that have explicit JMPs to labels and the corresponding labels. Figure 3 illustrates the readability of assembly code using the macros for structured programming.

The increased readability can be advantageous to programmers who are accustomed to using

Figure 4: Two Open Strings of IFMs in a Set of Nested IFMs

```
IFM E
   IFM NE
      IFM B
      ENDIFM    (*)
      IFM E
         IFM NE
         ENDIFM   (**)
         IFM E
         ENDIFM   (***) (3)
      ENDIFM      (2)
   ENDIFM
ENDIFM          (1)
```

higher-level languages, such as PL/1, Pascal, etc., because with the structured programming macros, programs will look more like those created with a higher-level language. More importantly, with the macros it is easier to structure assembly language programs in the

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Table 1: Valid Structured Programming Macro Formats

```
1. The IFM Set:

     Format                              Example
----------------                    -----------------------
                                           CMP   DL,BYTE PTR
       IFM P1                              IFM E
+      J[P1] ?IF1                    +     JE    ?IF1
+      JMP   ?IS1                    +     JMP   ?IS1
+?IF1                                +?IF1:
           .                                   .
          code A                              code A
           .                                   .
       ELSEM                               ELSEM
+      JMP   ?IE1                    +     JMP   ?IE1
+?IS1:                               +?IS1:
           .                                   .
          code B                              code B
           .                                   .
       ENDIFM                              ENDIFM
+?IE1:                               +?IE1:

                    ***********************

       IFM P1,P2,P3,P4                     IFM CMP,DL,E,0
+      P1    P2,P4                   +     CMP   DL,0
+      J[P3] ?IF1                    +     JE    ?IF1
+      JMP   ?IS1                    +     JMP   ?IS1
+?IF1                                +?IF1:
           .                                   .

                    ***********************

       IFM P1,P2,P3,P4,OR,P5,P6,P7,P8    IFM CMP,DL,E,0,OR,CMP,CL,E,0
+      P1    P2,P4                   +   CMP   DL,0
+      J[P3] ?IF1                    +   JE    ?IF1
+      P5    P6,P8                   +   CMP   CL,0
+      J[P7] ?IF1                    +   JE    ?IF1
+      JMP   ?IS1                    +   JMP   ?IS1
+?IF1:                               +?IF1:
           .                                   .

                    ***********************
```

```
2. The DO Set:

     Format                              Example
--------------                      -----------------------
       DO INF                              DO INF
+?DW1:                               +?DW1:
           .                                   .
          code A                              code A
           .                                   .
           DOEXIT P1                           DOEXIT E
+          J[¯P1] ?DX10              +         JNE   ?DX10
+          JMP    ?DE1               +         JMP   ?DE1
+?DX10:                              +?DX10:
           .                                   .
          code B                              code B
           .                                   .
           DOEXIT P1                           DOEXIT NE
+          J[¯P1] ?DX11              +         JE    ?DX11
+          JMP    ?DE1               +         JMP   ?DE1
+DX11:                               +DX11:
           .                                   .
          code C                              code C
           .                                   .
       ENDDO                               ENDDO
+          JMP   ?DW1                +         JMP   ?DW1
+?DE1:                               +?DE1:

                    ***********************

       DO WHILE,P1,P2,P3,P4                DO WHILE,CMP,DL,E,0
+?DW1:                               +?DW1:
+          P1    P2,P4               +         CMP   DL,0
+          J[P3] ?DL1                +         JE    ?DL1
+          JMP   ?DE1                +         JMP   ?DE1
+?DL1:                               +?DL1:
           .                                   .
          code A                              code A
           .                                   .
           DOEXIT P1,P2,P3,P4                  DOEXIT CMP,CL,E,0
+          P1    P2,P4               +         CMP   CL,0
+          J[¯P3] ?DX20:             +         JNE   ?DX20
+          JMP   ?DE1                +         JMP   ?DE1
```

same way as those using a higher-level language are structured.

DRAWBACKS OF MACROS

Although these structured programming macros provide significant advantages, they do have some disadvantages. First and foremost, whenever macros are used the compile time is significantly increased. For instance, one small test program of 150 statements took 1 minute to compile. The same program written with structured programming macros (one INITDOIF, eight IFMs with corresponding ENDIFMs, one ELSEM, one DO WHILE, and one DO UNTIL) took 2 minutes and 45 seconds. For some experienced programmers this could be a deciding factor against using these macros, because the time gained in using them may be lost in waiting for compilations to complete.

One way to overcome this disadvantage is to keep programs as modular as possible by building a module for each logical function required by the program. Then when changes are necessary only the modules affected need to be recompiled, and all the modules can be relinked to form the revised program.

Another disadvantage of structured programming macros is that they will increase the size of the object and load modules. The programmer functioning without structured programming macros can choose more efficiently how to jump (short or long) and when to do it. Long jumps (JMP) generate 3 bytes of code and short jumps (JE, JNE, etc.) generate 2 bytes.

With the structured programming macros that accompany this article, the jumps to the ELSEM, ENDIFM, or ENDDO are always long, so it will not matter how many lines of code are between the

> *In weighing the advantages and disadvantages of using structured programming macros, it seems the advantages outweigh the disadvantages.*

header macro (IFM or DO) and its matching ending macro (ELSEM, ENDIFM, or ENDDO). The long JMP generated by IFM, ELSEM, or DO may be avoided if the programmer generates that jump.

```
+?DX20:                           +?DX20:
            .                                 .
          code B                            code B
            .                                 .

                 ***********************

      DO UNTIL,P1,P2,P3,P4              DO UNTIL,CMP,DL,E,0
+?DW1:                            +?DW1:
+        P1    P2,P4              +        CMP   DL,0
+        J[~P3] ?DL1              +        JNE   ?DL1
+        JMP    ?DE1              +        JMP   ?DE1
+?DL1:                            +?DL1:
            .                                .
            .                                .

                 ***********************

      DO FROM,P1                        DO FROM,DX
+?DW1:                            +?DW1:
+        DEC   P1                 +        DEC   DX
+        JGE   ?DL1               +        JGE   ?DL1
+        JMP   ?DE1               +        JMP   ?DE1
+?DL1:                            +?DL1:
            .                                 .
          code A                            code A
            .                                 .
      ENDDO                             ENDDO
+        JMP   ?DW1               +        JMP   ?DW1
+?DE1:                            +?DE1:

                 ***********************

      DO FROM,P1,P2                     DO FROM,DX,10
+        MOV   P1,P2              +        MOV   DX,10
+?DW1:                            +?DW1:
+        DEC   P1                 +        DEC   DX
+        JGE   ?DL1               +        JGE   ?DL1
+        JMP   ?DE1               +        JMP   ?DE1
+?DL1:                            +?DL1:
            .                                 .
          code A                            code A
            .                                 .
      ENDDO                             ENDDO
+        JMP   ?DW1               +        JMP   ?DW1
+?DE1:                            +?DE1:

                 ***********************

      DO FROM,P1,P2,P3                  DO FROM,DX,10,2
+        MOV   P1,P2              +        MOV   DX,10
+?DW1:                            +?DW1:
+        SUB   P1,P3              +        SUB   DX,2
+        JGE   ?DL1               +        JGE   ?DL1
+        JMP   ?DE1               +        JMP   ?DE1
+?DL1:                            +?DL1:
            .                                 .
          code A                            code A
            .                                 .
      ENDDO                             ENDDO
+        JMP   ?DW1               +        JMP   ?DW1
+?DE1:                            +?DE1:

                 ***********************

      DO FROM,P1,P2,P3,P4               DO FROM,DX,10,2,6
+        MOV   P1,P2              +        MOV   DX,10
+?DW1:                            +?DW1:
+        SUB   P1,P3              +        SUB   DX,2
+        CMP   P1,P4              +        CMP   DX,6
+        JGE   ?DL1               +        JGE   ?DL1
+        JMP   ?DE1               +        JMP   ?DE1
+?DL1:                            +?DL1:
            .                                 .
          code A                            code A
            .                                 .
      ENDDO                             ENDDO
+        JMP   ?DW1               +        JMP   ?DW1
+?DE1:                            +?DE1:
                 ***********************

Note: Up to three separate compare type statements may be connected
by ORs or ANDs.  Under the current implementation ORs and ANDs may not
be mixed.
```

RECOMMENDATIONS

The advantages of using structured programming macros seem to outweigh the disadvantages. The disadvantages discussed here might be important to an experienced assembly language programmer who, in any case, has probably developed techniques with which he or she is comfortable. For the beginner, however, the advantages can significantly increase the utility of the PC's macro assembly language.

In its current state, the IBM PC macro assembly language is not very friendly to the implementation of structured programming macros. The IBM 370 assembly language has indexed global variables that can be used to stack the references to labels to which the header macros must build jumps. When the trailer macros are encountered in the code these references can be unstacked to build the actual labels referenced in the header macro.

The PC's macro assembly language provides two pseudo-ops that, although not as convenient as a stack, nonetheless make it possible to provide an elegant and efficient implementation of the structured programming macros. An inelegant solution would be one in which the programmer must provide, as an argument to each header macro (IFM or DO), a unique identifier that could be used by the macro to customize the labels it needs to generate. The two pseudo-ops are the equal sign (=) and the IFDEF.

The equal-sign pseudo-op allows the programmer to increment or decrement counters, which are then known globally—that is, to all the macros defined in the source code. This facility is used by the structured programming macros to customize the labels referenced by the header macros (IFM or DO) by appending a number to each label. In order to initialize the counters the INITDOIF macro must be included in the source code prior to the first use of any IFM or DO macros. Note that if the INITDOIF macro is not used before any IFM or DO macros, many error messages will be displayed saying that various labels have not been defined.

Because of the global counters referred to above, no more than four strings of DO or IFM macros may be open at any one time. This is because each time an open string is created a counter for that string

must be saved and a new counter begun. Currently there are only eight counters implemented, four for the IFM macro and four for the DO macro. See figure 4 for an illustration of two open strings of IFMs in a set of nested IFMs.

(In figure 4, the single asterisk indicates the closing ENDIFM of the last IFM in the first open string of IFMs. The IFM following that ENDIFM is assigned to be the second counter and begins the second string of open IFMs. The double asterisk indicates the closing ENDIFM of the last IFM in the second string of open IFMs. Following that, the next IFM is assigned to be the third counter, and the third string of open IFMs is closed immediately by the following ENDIFM, which is indicated by the triple asterisk. The numbers in parentheses indicate the closing of each of their respective strings of open IFMs.)

Fortunately, the limitation of four open strings of DO or IFM macros is the only restriction on nesting such macros; they can be nested in any combination desired. In fact, these two sets of structured programming macros for the IBM PC contain an enhancement not provided by the same macros for the IBM 370. If a PC IFM macro is nested within a PC DO macro and a PC DOEXIT macro is executed within the range of the IFM macro (that is, before the closing ENDIFM macro), the DOEXIT macro will jump to the proper ENDDO macro. In the IBM 370 assembly language, on the other hand, the structured programming macros will generate undefined symbols if DOEXIT macros are executed within IF macros.

The second pseudo-op that is necessary for an elegant solution to implementing structured programming macros on the IBM PC is the IFDEF or its complement, IFNDEF. These pseudo-ops are used to determine the next code produced by the macro assembler based on whether or not a symbol has been defined. Whenever an IFM macro is used, a JMP ?ISd: (where *d* stands for some number) is produced. This jump will be to either an ELSEM or an ENDIFM macro, depending on whether a matching ELSEM macro appears in the code for the header IFM macro. The ELSEM macro generates a JMP ?IEd: to the ENDIFM macro and a ?ISd: label to head the code for the else condition.

The ENDIFM macro determines whether to generate a ?ISd: or a ?IEd: label. Under the current implementation of the structured programming macros, the ENDIFM tests to see if the ?ISd: label has been defined. If it has, the ENDIFM generates a ?IEd: label; otherwise a ?ISd: label is generated. Surprisingly,

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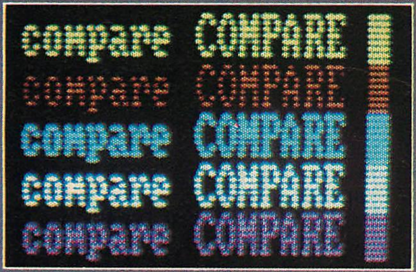

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the ?IEd: label is always generated by the ENDIFM macro, whether or not an ELSEM is included for the header IFM macro. This piece of magic is not documented in the Macro Assembly Language manual.

Surprisingly, the ?IEd: label is always generated by the ENDIFM macro, whether or not an ELSEM is included for the header IFM Macro. This piece of magic is not documented in the Macro Assembly Language manual that is provided by IBM.

Apparently the reference to the ?ISd: label—that is, JMP ?ISd:—generated by the header IFM macro constitutes definition of the symbol and not simply a reference. However, here is the magic: when no ?ISd: label is defined by an ELSEM macro, the macro assembler associates the reference to the ?ISd: label generated by the IFM with the ?IEd: label generated by the ENDIFM. The ?IEd: label prints in the expanded source listing of the compiled program. The ?ISd: label does not print in the expanded source listing but does print in the Symbol Table and the Cross Reference, along with the ?IEd: label.

The set of macros found in listings 1 through 9 will allow the programmer to take advantage of the speed and power of assembly language without giving up the convenience of structured programming.

Listing 1 INITDOIF Macro

```
INITDOIF MACRO
        ?CTD=0
        ?CTE=0
        ?CT2X=0
        ?CT3X=0
        ?CT4X=0
        ?S1 = 0
        ?S2 = 0
        ?S3 = 0
        ?S4 = 0
        ?CTI=0
        ?CTI2X=0
        ?CTI3X=0
        ?CTI4X=0
        ?SI1 = 0
        ?SI2 = 0
        ?SI3 = 0
        ?SI4 = 0
        ENDM
```

Listing 2 IFM Macro

```
IFM     MACRO P1,P2,P3,P4,O1,P5,P6,P7,P8,O2,P9,P10,P11,P12
        ?CTA = 0
        ?CTI = ?CTI + 1
        IFE ?SI1
            ?CTI1 = ?CTI
        ELSE
            IFE ?SI2
               IFE ?CTI2X
                  ?CTI2 = ?CTI
                  ?CTI2X = 1
               ELSE
                  ?CTI2 = ?CTI2 +1
                  ?CTI2X = ?CTI2X +1
               ENDIF
            ELSE
                  IFE ?SI3
                     IFE ?CTI3X
                        ?CTI3 = ?CTI
                        ?CTI3X = 1
                     ELSE
                        ?CTI3 = ?CTI3 +1
                        ?CTI3X = ?CTI3X +1
                     ENDIF
                  ELSE
                     IFE ?SI4
                        IFE ?CTI4X
                           ?CTI4 = ?CTI
                           ?CTI4X = 1
                        ELSE
                           ?CTI4 = ?CTI4 +1
                           ?CTI4X = ?CTI4X +1
                        ENDIF
                     ELSE
                        MJMP MP,?IFERR
                     ENDIF
                  ENDIF
               ENDIF
            ENDIF
        IFB <P2>
           MJMP  P1,?IF,%?CTI
           MJMP  MP,?IS,%?CTI
           MLBL  ?IF,%?CTI
        ELSE
           P1     P2,P4
           IFIDN <O1>,<AND>
              MJMP  P3,?IA,%?CTI,%?CTA
              MJMP  MP,?IS,%?CTI
              MLBL  ?IA,%?CTI,%?CTA
              ?CTA  =  ?CTA + 1
              P5     P6,P8
              MJMP  P7,?IA,%?CTI,%?CTA
              MJMP  MP,?IS,%?CTI
              MLBL  ?IA,%?CTI,%?CTA
              ?CTA  = ?CTA + 1
              IFIDN <O2>,<AND>
                 P9     P10,P12
```

```
            MJMP  P11,?IF,%?CTI
            MJMP  MP,?IS,%?CTI
          ENDIF
          MLBL  ?IF,%?CTI
        ELSE
          MJMP  P3,?IF,%?CTI
          IFIDN <01>,<OR>
            P5    P6,P8
            MJMP  P7,?IF,%?CTI
            IFIDN <02>,<OR>
              P9    P10,P12
              MJMP  P11,?IF,%?CTI
            ENDIF
          ENDIF
          MJMP  MP,?IS,%?CTI
          MLBL  ?IF,%?CTI
        ENDIF
      ENDIF
      ENDM
```

Listing 3 ELSEM Macro

```
ELSEM   MACRO
        IFE ?CTI2X
            ?CTX = ?CTI1
        ELSE
            IFE ?CTI3X
                ?CTX = ?CTI2
            ELSE
                IFE ?CTI4X
                    ?CTX = ?CTI3
                ELSE
                    ?CTX = ?CTI4
                ENDIF
            ENDIF
        ENDIF
        MJMP  MP,?IE,%?CTX
        MLBL  ?IS,%?CTX
        ENDM
```

Listing 4 ENDIFM Macro

```
ENDIFM  MACRO
        IFE ?CTI2X
            MALTLB ?IS,%?CTI1,?IE
            ?CTI1 = ?CTI1 - 1
            ?SI1 = 1
            IFE  ?CTI1
                ?SI1 = 0
            ENDIF
        ELSE
            IFE ?CTI3X
                MALTLB ?IS,%?CTI2,?IE
                ?CTI2 = ?CTI2 - 1
                ?CTI2X = ?CTI2X - 1
                ?SI2 = 1
                IFE ?CTI2X
                    ?SI2 = 0
                ENDIF
            ELSE
                IFE ?CTI4X
                    MALTLB ?IS,%?CTI3,?IE
                    ?CTI3 = ?CTI3 - 1
                    ?CTI3X = ?CTI3X - 1
                    ?SI3 = 1
                    IFE ?CTI3X
                        ?SI3 = 0
                    ENDIF
                ELSE
                    MALTLB ?IS,%?CTI4,?IE
                    ?CTI4 = ?CTI4 - 1
                    ?CTI4X = ?CTI4X - 1
                    ?SI4 = 1
                    IFE ?CTI4X
                        ?SI4 = 0
                    ENDIF
                ENDIF
            ENDIF
        ENDIF
        ENDM
```

Listing 5 DO Macro

```
DO      MACRO TYP1,P1,P2,P3,P4
        ?CTD = ?CTD + 1
        IFE ?S1
            ?CT1 = ?CTD
        ELSE
            IFE ?S2
                IFE ?CT2X
                    ?CT2 = ?CTD
                    ?CT2X = 1
                ELSE
                    ?CT2 = ?CT2 +1
                    ?CT2X = ?CT2X +1
                ENDIF
            ELSE
                IFE ?S3
                    IFE ?CT3X
                        ?CT3 = ?CTD
                        ?CT3X = 1
                    ELSE
                        ?CT3 = ?CT3 +1
                        ?CT3X = ?CT3X +1
                    ENDIF
                ELSE
                    IFE ?S4
                        IFE ?CT4X
                            ?CT4 = ?CTD
                            ?CT4X = 1
                        ELSE
                            ?CT4 = ?CT4 +1
                            ?CT4X = ?CT4X +1
                        ENDIF
                    ELSE
                        MJMP MP,?DOERR
                    ENDIF
                ENDIF
            ENDIF
        ENDIF
        IFIDN <TYP1>,<INF>
            MLBL  ?DW,%?CTD
        ELSE
        IFIDN <TYP1>,<WHILE>
            MLBL  ?DW,%?CTD
            P1    P2,P4
            MJMP  P3,?DL,%?CTD
            MJMP  MP,?DE,%?CTD
            MLBL  ?DL,%?CTD
        ELSE
        IFIDN <TYP1>,<UNTIL>
            MLBL  ?DW,%?CTD
            P1    P2,P4
            MJMPN P3,?DL,%?CTD
            MJMP  MP,?DE,%?CTD
            MLBL  ?DL,%?CTD
        ELSE
        IFIDN <TYP1>,<FROM>
            IFNB <P2>
                MOV   P1,P2
            ENDIF
            MLBL  ?DW,%?CTD
            IFNB  <P3>
                SUB   P1,P3
            ELSE
                DEC   P1
            ENDIF
            IFNB <P4>
                CMP   P1,P4
            ENDIF
            MJMP  GE,?DL,%?CTD
            MJMP  MP,?DE,%?CTD
            MLBL  ?DL,%?CTD
        ELSE
        MJMP  MP,?BADDO,%?CTD
        ENDIF
        ENDIF
        ENDIF
        ENDIF
        ENDM
```

Listing 6 DOEXIT Macro

```
DOEXIT  MACRO P1,P2,P3,P4
        IFE ?CT2X
            ?CTX = ?CT1
        ELSE
            IFE ?CT3X
                ?CTX = ?CT2
            ELSE
                IFE ?CT4X
                    ?CTX = ?CT3
                ELSE
                    ?CTX = ?CT4
                ENDIF
            ENDIF
        ENDIF
        IFB <P1>
            MJMP  MP,?DE,%?CTX
        ELSE
        IFB <P2>
            MJMPN P1,?DX,%?CTX,%?CTE
            MJMP  MP,?DE,%?CTX
            MLBL  ?DX,%?CTX,%?CTE
            ?CTE  = ?CTE +1
        ELSE
            P1    P2,P4
            MJMPN P3,?DX,%?CTX,%?CTE
            MJMP  MP,?DE,%?CTX
            MLBL  ?DX,%?CTX,%?CTE
            ?CTE  = ?CTE +1
        ENDIF
        ENDIF
        ENDM
```

Listing 7 ENDDO Macro

```
ENDDO   MACRO
        IFE ?CT2X
            MJMP MP,?DW,%?CT1
            MLBL ?DE,%?CT1
            ?CT1 = ?CT1 - 1
            ?S1 = 1
            IFE  ?CT1
                ?S1 = 0
                ?CTE = 0
            ENDIF
        ELSE
            IFE ?CT3X
                MJMP MP,?DW,%?CT2
                MLBL ?DE,%?CT2
                ?CT2 = ?CT2 - 1
                ?CT2X = ?CT2X - 1
                ?S2 = 1
                IFE ?CT2X
                    ?S2 = 0
                ENDIF
            ELSE
                IFE ?CT4X
                    MJMP MP,?DW,%?CT3
                    MLBL ?DE,%?CT3
                    ?CT3 = ?CT3 - 1
                    ?CT3X = ?CT3X - 1
                    ?S3 = 1
                    IFE ?CT3X
                        ?S3 = 0
                    ENDIF
                ELSE
                    MJMP MP,?DW,%?CT4
                    MLBL ?DE,%?CT4
                    ?CT4 = ?CT4 - 1
                    ?CT4X = ?CT4X - 1
                    ?S4 = 1
                    IFE ?CT4X
                        ?S4 = 0
                    ENDIF
                ENDIF
            ENDIF
        ENDIF
        ENDM
```

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clear	–clear monitor screen	**pwd**	–print working directory
cmp	–compare files	**rm**	–remove files (delete)
comm	–output lines common to two files	**sh**	–shell (command interpreter)
cp	–copy files	**size**	–size of object code
cpio	–file backup/archival	**sort**	–sort numerically or alphabetically
date	–get or set date and time	**sum**	–checksum file
echo	–echo arguments to stdout	**tail**	–output last lines of file
expand	–expand tabs into spaces	**tee**	–pipe fitting
expr	–string and arithmetic evaluation	**test**	–test file's or string's characteristics
false	–do nothing, unsuccessfully	**time**	–determine time to execute a command
find	–produce list of selected files	**tr**	–translate or delete characters
grep	–search files for specified pattern	**true**	–do nothing, successfully
hd	–hex file dumper	**unexpand**	–replace spaces with tabs
head	–output 1st lines of file	**uniq**	–remove duplicate lines
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more	–copy files to display	**words**	–output file 1 word per line
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Listing 8 MLBL, MALTLB, and MJMP Macros

```
MLBL     MACRO P1,CT1,CT2
&P1&CT1&CT2:
         ENDM

MALTLB   MACRO  P1,P2,P3
         IFDEF &P1&P2
            MLBL P3,P2
         ELSE
            MLBL P1,P2
         ENDIF
         ENDM

MJMP     MACRO P1,P2,CT1,CT2,P3,CT3
         IFNB <P3>
&P3&CT3: J&P1  &P2&CT1&CT2
         ELSE
         J&P1  &P2&CT1&CT2
         ENDIF
         ENDM
```

Listing 9 MJMPN Macro

```
MJMPN    MACRO P1,P2,CT1,CT2,P3,CT3
         IFIDN <P1>,<E>
         MJMP  NE,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<Z>
         MJMP  NZ,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<NE>
         MJMP  E,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<NZ>
         MJMP  Z,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<BE>
         MJMP  NBE,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<NA>
         MJMP  A,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<NBE>
         MJMP  BE,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<A>
         MJMP  NA,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<AE>
         MJMP  NAE,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<NB>
         MJMP  B,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<NAE>
         MJMP  AE,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<B>
         MJMP  NB,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<G>
         MJMP  NG,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<NLE>
         MJMP  LE,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<NG>
         MJMP  G,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<LE>
         MJMP  NLE,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<GE>
         MJMP  NGE,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<NL>
         MJMP  L,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<NGE>
         MJMP  GE,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<L>
         MJMP  NL,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<O>
         MJMP  NO,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<NO>
         MJMP  O,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<NS>
         MJMP  S,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<S>
         MJMP  NS,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<NP>
         MJMP  P,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<P>
         MJMP  NP,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<PO>
         MJMP  PE,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<PE>
         MJMP  PO,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<NC>
         MJMP  C,P2,CT1,CT2,P3,CT3
         ELSE
         IFIDN <P1>,<C>
         MJMP  NC,P2,CT1,CT2,P3,CT3
         ELSE
         MJMP  MP,?BADOP,CT1
         ENDIF
         ENDIF
         ENDIF
         ENDIF
         ENDIF
         ENDIF
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         ENDIF
         ENDM
```

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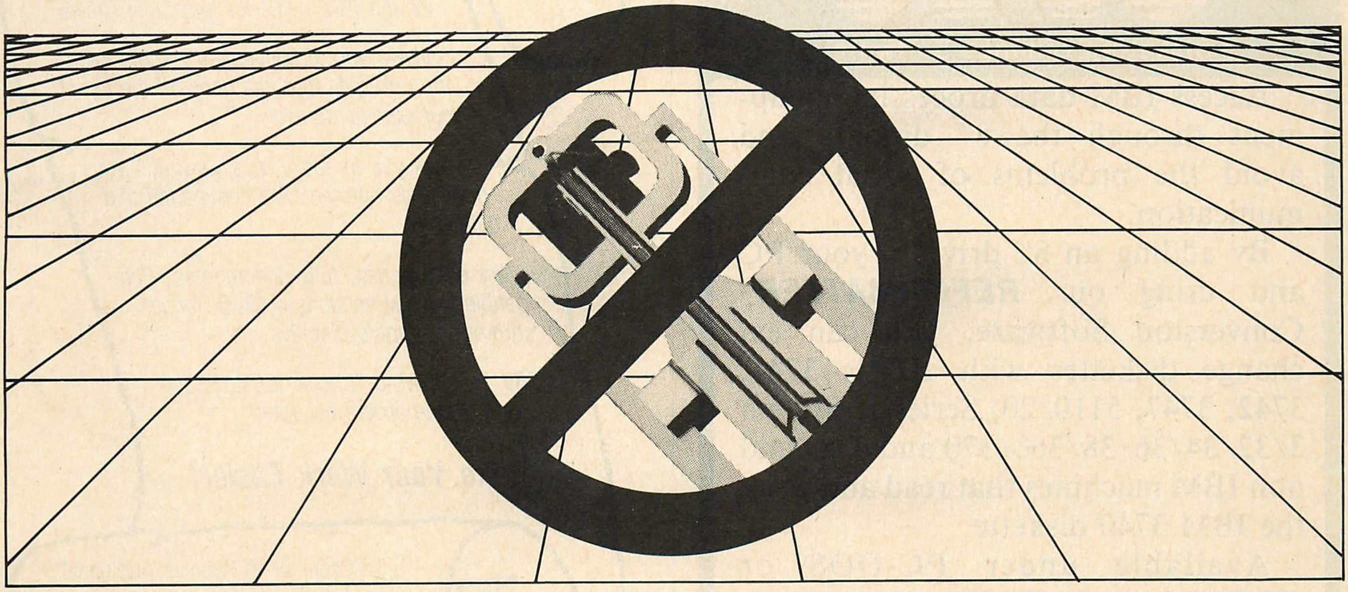

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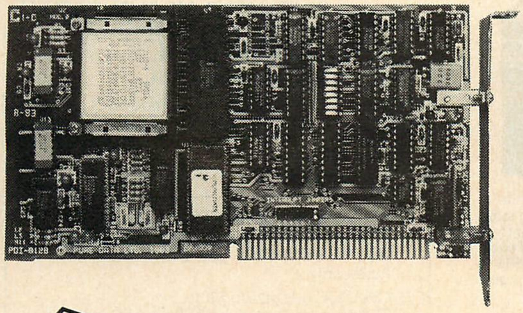

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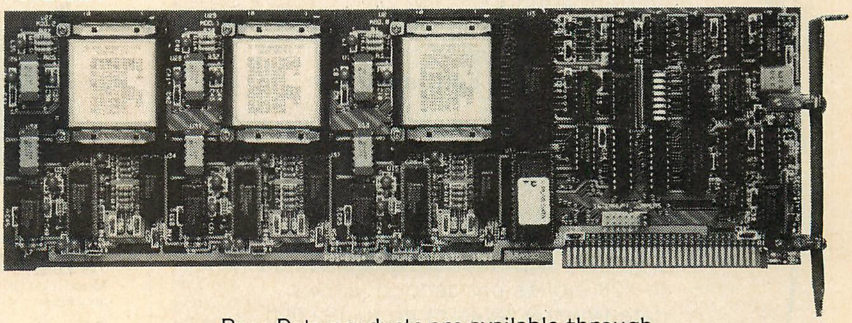

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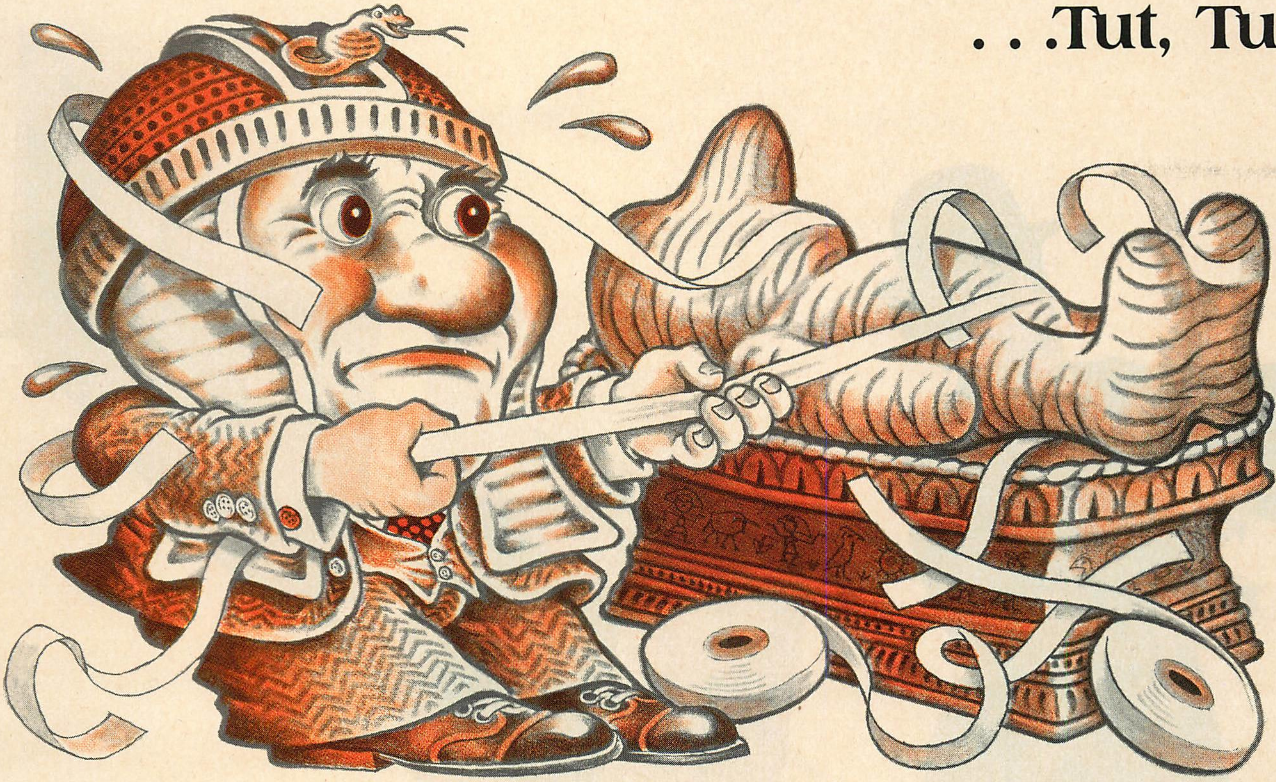

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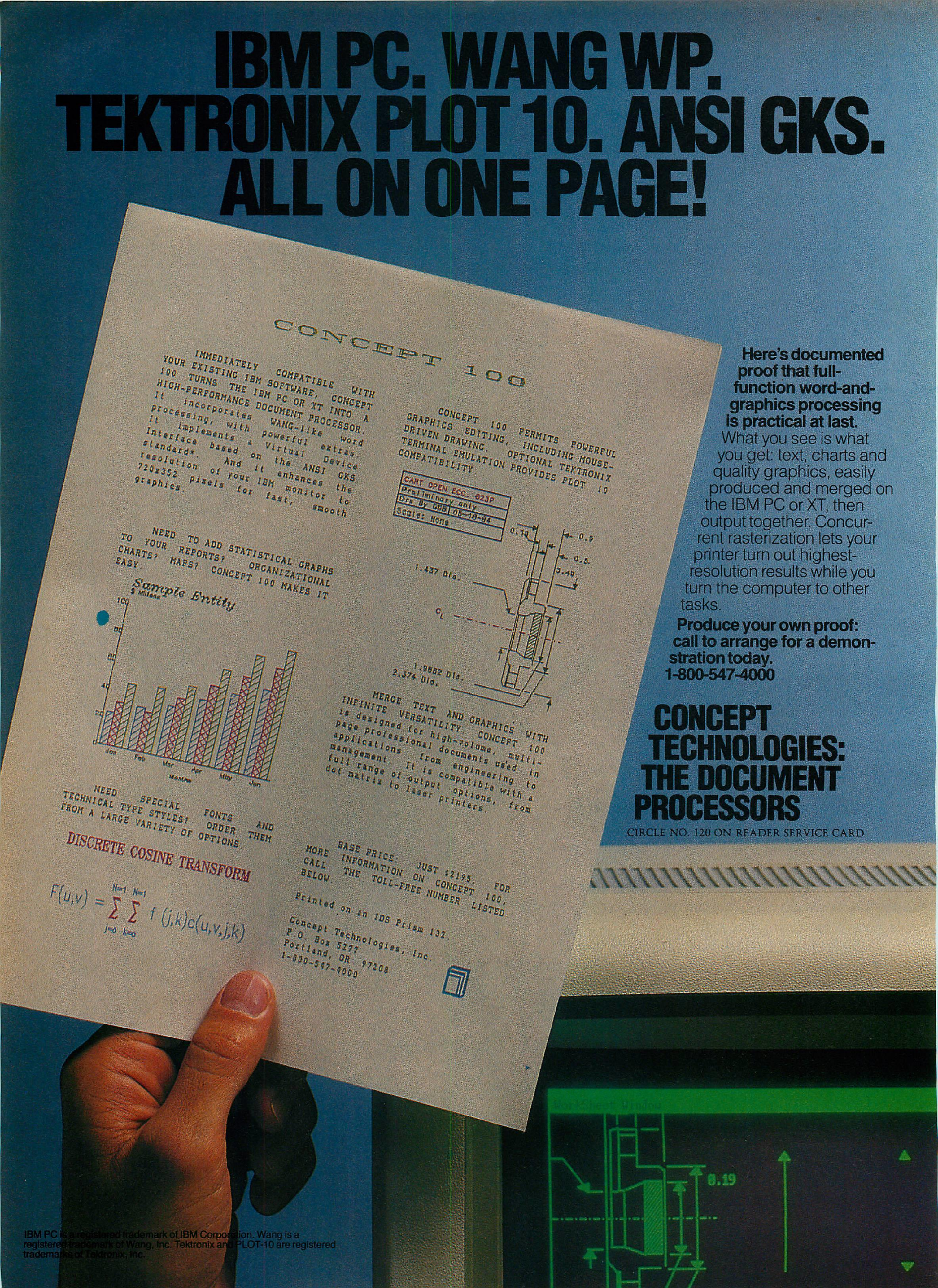
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ASSEMBLERS WITHOUT ULCERS

Advanced macro techniques for ASM-86

Eric S. Raymond

Machine-language programming is often a painful chore for even the most experienced programmers. Assemblers are notoriously tricky, unforgiving beasts that embody all the most frustrating characteristics of dealing with computers. However, higher-level languages often fail to give the user access to the full power of the machine, and they produce less-than-optimum code, costing the user lots of time and/or making the program much larger than strictly necessary.

Sometimes the efficiency and total control of assemblers is required. One way to get that control on the IBM PC without descending to the masochistic depths plumbed by hard-core assembly hackers is with ASM-86's macro feature.

Shorthand

A macro is a way of replacing one piece of text with another. With macros you can invent a shorthand that brings your assembler closer to the language you want to speak without introducing the inefficiencies of a compiler or interpreter. Unlike higher-level languages, macros won't directly help you reduce the bug vulnerability of your programs, but they can help you reuse debugged instruction sequences.

The macro features of ASM-86 are documented in chapter 5 of the *Macro Assembler* manual, on pages 5-48 to 5-69; conditional pseudo-ops are documented on pages 5-44 to 5-48. The ASM-86 manual is not a masterpiece of clarity overall, and the sections on pseudo-ops and macros are particularly obscure. By the time you've read this article, though, you'll be able to make the assembler do wonders. Let's start

Eric Raymond is a software designer working on UNIX applications for Rabbit Software of Malvern, PA. His background is in artificial intelligence research, language design, and software engineering techniques. He is writing a book on portability under UNIX. He owns a PC with a very low serial number.

Figure 1: MOVE Macro

```
MOVE   MACRO  D,S   ;;Memory-to-memory move
       MOV AX,S     ;;Fetch source to scratch register
       MOV D,AX     ;;Move contents of scratch to target
       ENDM          ;;End of MOVE
```

Figure 2: Modified MOVE Macro

```
MOVE    MACRO  D,S    ;;Memory-to-memory move
        PUSH   AX     ;;Save previous contents of scratch register
        MOV    AX,D   ;;Move source to scratch
        MOV    S,AX   ;;Move scratch to target
        POP    AX     ;;Restore contents of scratch
        ENDM          ;;End of MOVE
```

Figure 3: Final Modified MOVE Marco

```
MOVE    MACRO   D,S                    ;;Anything-to-anything move
        IF (D,S aren't both memory)    ;;If D or S is a register
        MOV     D,S                    ;;do a MOV
        ELSE                           ;;else
        PUSH    AX                     ;;save AX
        MOV     AX,D                   ;;use it as scratchpad
        MOV     S,AX                   ;;finish the move
        POP     AX                     ;;restore AX
        ENDIF                          ;;end of if
        ENDM                           ;;End of MOVE
```

with an example of what can be done using macros.

In 8088 machine language one instruction can move data from register to register, or from memory to register, or from register to memory, but not directly from memory to memory. If you've gotten tired of coding things like

MOV AX, SOURCEWORD
MOV DESTINATION, AX

when what you want is

MOV DESTINATION, SOURCEWORD

then you're ready for a macro. Put figure 1 in front of your program. This tells the assembler to substitute the lines between MACRO and ENDM anywhere it sees MOVE in the program. D and S are like function arguments in a higher-level languages: they tell ASM-86 where to substitute the tokens it sees on the line after MOVE. Note, by the way, the use of semicolons to start comments that shouldn't be included in the expansion. Macros, like assembler code, should be heavily commented for readability.

Then you can write

ADD ALPHA, 2 ;ALPHA is a memory location
MOVE SCRATCH, ALPHA ;So is SCRATCH
AND CX, SCRATCH

and the assembler will see:

ADD ALPHA, 2
MOV AX, ALPHA
MOV SCRATCH, AX
AND CX, SCRATCH

You can now view MOVE as an extra assembler instruction, but you're in trouble if you use it somewhere that destroys an important AX value. This illustrates the major pitfall of macros: they can hide nasty side effects. One way to fix this is found in figure 2. Note that using a macro for an instruction sequence doesn't generate any less code than writing the instructions out by hand; it just saves time and may make the program more readable. ASM-86 expands all macros during pass 1.

MOVE still has a problem. If either D or S are registers, then four instructions have been generated

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Figure 4: Parameter-testing Fragment

```
MOVE    MACRO   D,S           ;;Anything-to-anything move
        ISREG   DR,D          ;;DR<-0,1 as D is/is not a register
        ISREG   SR,S          ;;DS<-0,1 as S is/is not a register
        IF      (DR OR SR)    ;;If D or S is a register
        MOV     D,S           ;;do a MOV
        ELSE                  ;;else
        PUSH    AX            ;;save AX
        MOV     AX,D          ;;use it as scratch pad
        MOV     S,AX          ;;finish the move
        POP     AX            ;;restore AX
        ENDIF                 ;;end of if
        ENDM                  ;;End of MOVE
```

Figure 5: ISREG Macro

```
ISREG   MACRO    RES,ARG  ;;RES <- 0 or 1 as ARG is/not a register
        RES      =0       ;;Start off assuming it's not
        IRP   X, <AH,BH,CH,DH,AL,BL,CL,DL,AX,BX,CX,DX,SI,DI,BP,SP>
        IFIDN <X>,ARG>    ;;If it's in the list
        RES      =1       ;;return 1
        ENDIF             ;;End of test
        ENDM              ;;End of IRP
        ENDM              ;;End of ISREG
```

Figure 6: CASE Macro

```
CASE MACRO   KEY, VALS, LABELS   ;;CASE statement for assembler
        X       = 0              ;;Initialize value counter
        IRP       X,VALS         ;;Loop through key-values list
        X       = X+1            ;;counting from 1 to its length
        NTH       L,X,LABELS     ;;Get the nth label to L
        NTH       V,X,VALUES     ;;Get the nth label to V
        CMP       KEY,V          ;;Generate code to see if KEY=V
        JZ        L              ;;and jump to L if true
        ENDM                     ;; then exit the loop
        ENDM                     ;;End of CASE
```

Figure 7: INTFUN Macro

```
; function inkey: char; -- the Pascal header
 INKEY   PROC    FAR     ;Return char in AL, no echo.
         INTFUN  16H,0   ;Char in AL, scan code in AH
         TEST    AL,AL   ;Is character null?
         JNZ     NORMAL  ;If not, we're done
         ADD     AH,80H  ;If so, meta the scan code
         XCHG    AL,AH   ; and arrange to return it.
 NORMAL: RET
 INKEY   ENDP
```

where one would do. To fix this, conditionals must be used (see manual pages 5-44 and 5-45). The logic we want can be seen in figure 3.

Fortunately, macros can call other macros. To test a macro to see if a parameter is a register, use the fragment in figure 4.

To write ISREG (see figure 5), introduce the IRP operator, which permits you to loop through a list of arguments. This list is bounded by angle brackets and treated like a single argument; the <> act like quotes. IRP also requires a dummy-variable argument to hold the list member it's currently looking at. I use X. Modularizing code into small functional pieces pays off in ease-of-maintenance and reusability. ISREG and MOVE can now be put in a macro utilities file (INCLUDEd when needed), and both of these macros can also be reused as building blocks for other macros.

It should be obvious by now that ASM-86 macro is a full programming language; it can express conditionals and loops. Consider the CASE macro in figure 6. It depends, of course, on NTH, which is left as an exercise for the reader (hint: look

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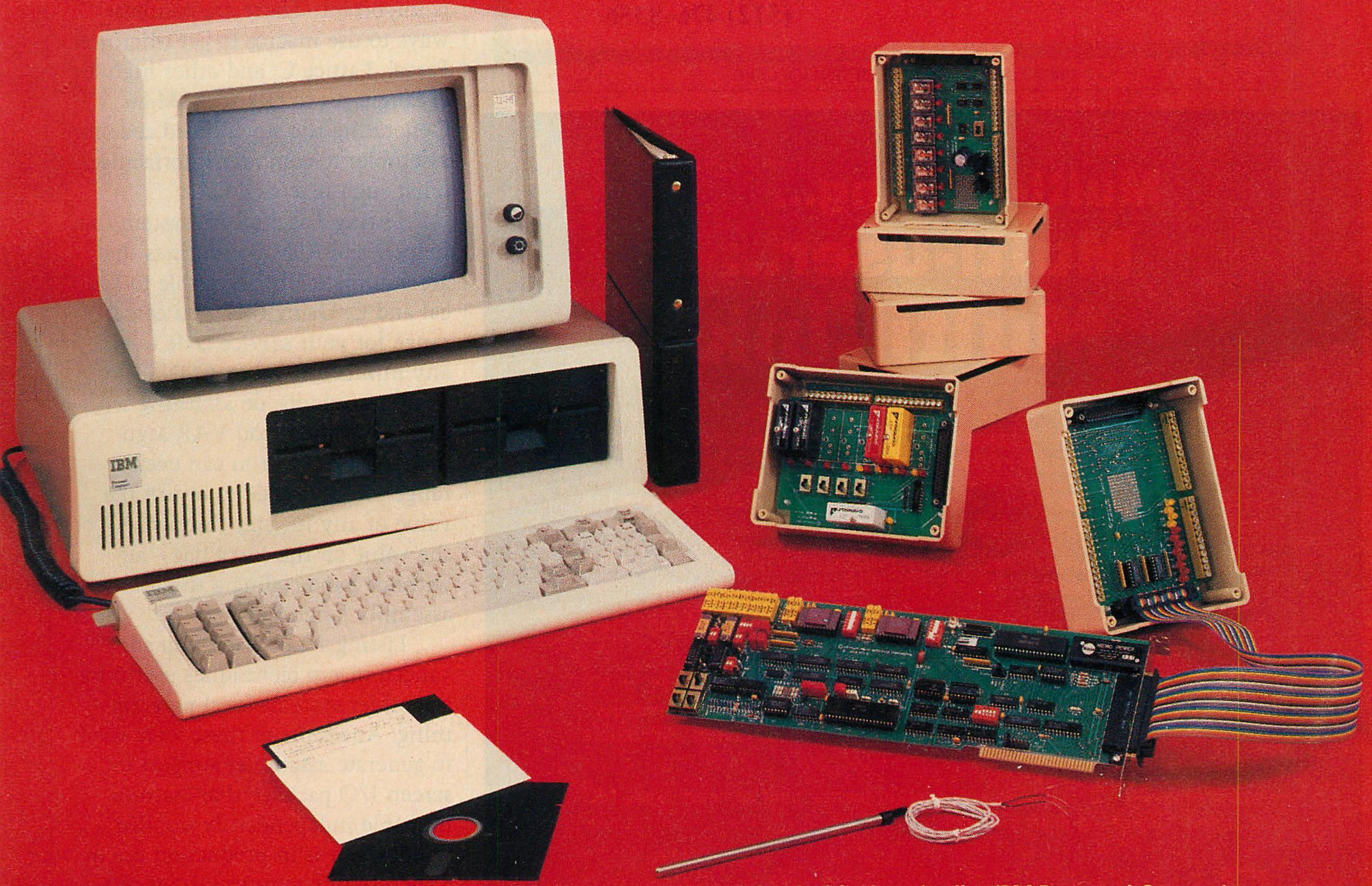

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at the IRP loop in ISREG again). If you have the correct answer,

CASE AX, <1, 2, 3, 4>, <PROCA, PROCB, PROCC, PROCD>

automatically generates a dispatch table based on the value of AX. Macros can enable you to turn your ASM-86 into something resembling a structured programming language. Once you've written something like CASE and verified that it expands correctly, you never have to hand-code a dispatch table again. Furthermore, when you reuse macros that you know have worked you can have more confidence in your code.

Macro System for ASM Routines

Macros don't provide the safety net a good compiler or interpreter does, so assembler-to-compiler interfacing is important. There are painless ways to use macros to get Microsoft Pascal, Lattice C, and other high-level languages to talk to ASM-86. Generating the stereotyped code for assembler-to-compiler interfacing is what such macros do best.

Listing 1 is a macro system that helps write ASM-86 routines that are automatically accessible to Pascal and C. Using this, you can arrange for your service code to take any number of value, CONST, or VAR arguments, do anything with them, and then load VAR arguments back out. You can even arrange for your code to return the value of any register through AX or the value on the carry-flag—all without hand-coding a single line of assembly language.

Listing 1 can teach you advanced macro techniques useful for assembler systems-level programming. Ancestors of these were used to generate assembler support for a screen I/O package that features multiple independently-scrolled windows; it is in production use in a successful communications program. The following examples of the macro system are working rou-

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Figure 8: Screen-writing Procedure

```
;procedure write_screen(char c; byte att);
                %OUT    WRITE_SCREEN
WRITE_SCREEN    PROC            FAR
;Write char with attribute & advance cursor,
;noticing screen boundaries.
                PROLOG  <CHAR, ATTR>
;Make sure BH contains current display page number
                INTFUN  10H,15
                MOV             CL,AH ;Save the
                                      ;screen width
                                      ;as well
;Read cursor position into DH, DL
                PUSH            CX  ;Save CX away
                                    ;because cursor
                INTFUN    10H,3     ;bounds get put
                                    ;in it.
                POP             CX  ;Restore screen
                                    ;width to CL
;Get the arguments
                GETVAL    AL,CHAR   ;The character
                GETVAL    BL,ATTR   ;The attribute
;Dispatch to handle special characters
                CMP             AL,0AH  ;A line feed?
                JE              SLFP    ;Must ignore them.
                CMP             AL,0DH  ;A carriage return?
                JE              SCRP
;Otherwise write the char normally
                PUSH            CX    ;Save the screen width
                MOV             CX,1 ;1 char only
                INTFUN  10H,9         ;Write char & attribute
                POP             CX
;Position the cursor for next char
                INC             DL
                CMP             DL,CL     ;Are we at EOL?
                JNZ             SSETNRET ;If not, set cursor
                MOV             DL,0      ;Else go to left column
                CMP             DH,24
                JNZ             SBUMPROW
;If we're here, have to set cursor & scroll the
;window 1 line up
SSETNSCROLL:    INTFUN  10H,2             ;First, set cursor
                MOV             AL,1  ;Want to scroll 1 line up
;Now do the scroll up
SSCROLL:        MOV             AH,6
                MOV             DH,24
                MOV             DL,CL  ;Get the screen width
                MOV             CX,0
                MOV             BH,07H ;Use normal blanks
SFUNCRET:       INT             10H    ;Execute pending function
SLFP:
                EPILOG
;If we're here, just need to bump row number
SBUMPROW:       INC             DH
SSETNRET:       MOV             AH,2
        JMP             SFUNCRET
;Here's the carriage-return processing (with auto-line-feed)
SCRP:   MOV             DL,0                ;Take cursor to
                                            ;left margin
                CMP             DH,24       ;Are we on last line?
                JNE             SBUMPROW    ;If no, bump row
                JMP             SSETNSCROLL ;else set cursor
                                            ;& scroll
                %OUT
WRITE_SCREEN    ENDP
```

Figure 9: SYS Macro

```
        ;procedure read_cpos(dpage: sint; var i, j, ctop, cbot: ;sint)
SYS     READ_CPOS, 10H, 7, <BH, *DH, *DL, *CH, *CL>
```

tines taken from this video support package. Explanations of the macros' functions will be given afterwards.

Non-Echoing Keyboard Input (INTFUN)

The return conventions of the INT 16/ AH = 0 call that MS-DOS uses for keyboard input make life unnecessarily difficult. Instead of mapping the function and special keys into the 128+ high half of the ASCII character set and returning a single byte in AL, it returns 0 in AL and a byte in AH; MS-DOS aids and abets this by requiring a second key read to detect the one keystroke. Macros can be used to give Pascal an INKEY function that acts rationally and serves as a real-world example of the use of the simplest of these macros, INTFUN (see figure 7).

Writing to the Screen with a Highlight (PROLOG/EPILOG)

Another poorly designed feature in the BIOS is found in the code for INT 10H / AH - 14 (WRITE_TTY), line 4694 of the BIOS figure in the *Technical Reference* manual (line 4965 in the revised version). If this had read MOV AH, 9 WRITE_TTY would use BL as a screen highlight on the monochrome monitor as well as on the color monitor (see figure 8). Note the use of "named" arguments and GETVAL; though this example doesn't show it, PROLOG also accepts register-name arguments that act in SYS below (see the figure comments for details). Also note that EPILOG need not be at the physical end of the function text, as long as all exits go through it.

Reading the Cursor Position (SYS)

As you can see in figure 9, SYS calls PROLOG and EPILOG to generate a call to interrupt 10H, AH=7 surrounded by stack fetches and loads that bring the first argument of the call into BH and load the results (which live in the CX and DX pairs) out to Pascal VAR arguments.

INTFUN is a simple straight-line macro for calling in-ROM BIOS functions. It's there mainly to be used by SYS, which is a specialized macro that uses PROLOG/EPILOG for getting at the ROM and DOS service routines. If you bracket an assembler service routine with PROLOG and EPILOG they'll generate the argument fetches and stores necessary to make it look like a Pascal procedure or function.

Notice that the line EPILOG MACRO REG is inside the scope of the PROLOG macro definition. This is an example of a macro-defining macro. Each time PROLOG is expanded it redefines EPILOG.

This is necessary because of an inconsistency in ASM-86. Angle-bracketed argument lists are treated like single arguments in macro headers, but they can't be passed to a symbol. The assignment

REGLIST = <AX, BX, CX, DX>

fails because a comma is defined to

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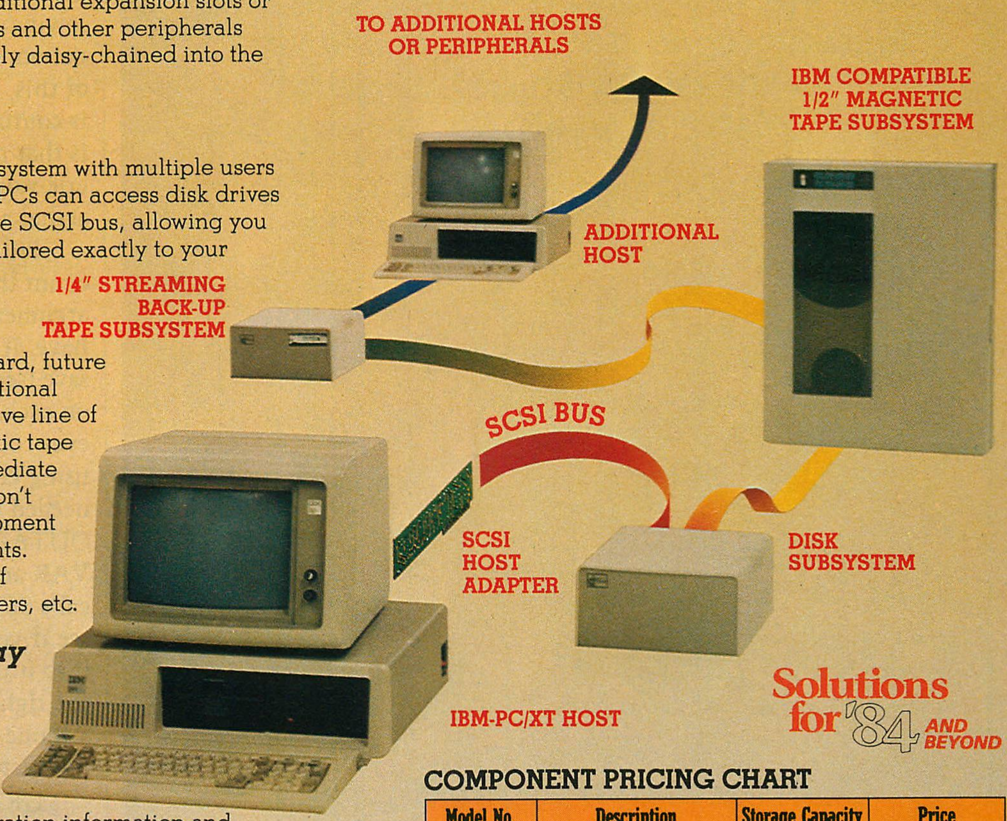

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end an angle-bracketed quote. This is documented, so it's a design error rather than a bug. It means that any time you want to pass one of these lists out of a macro you'll have to do so by defining another macro with the list expanded inside it.

I call this trick lambda-passing after a similar technique used in the language LISP. Usually, as here, you'll define a dummy with a nice name that does nothing but call the real receiving macro (ENDF) with its arguments filled in. This language also needs an operator that replaces the symbol or expression following it with its expansion or evaluation. The percent sign does part of this, but the documentation on it is confusing; what it boils down to is that it can be used only on numeric-valued expressions appearing as actual arguments to a macro call.

PROLOG calls ACOUNT to count the number of each kind of argument the generated routine will have. It generates a frame pointer save (see below), then calls INARG on each argument to generate whatever code is needed to access it, using GETVAL and the EPILOG needed to balance it. EPILOG calls OUTARG to generate code for each VAR argument (OUTARG in turn calls SETVAR). Next it checks to see if you wanted a function return; if so it uses MOVACC to put it in the right place. Finally it generates a frame pointer restore and the appropriate RET instruction.

GETVAL can be used directly to fetch, off the stack and to a register in mid-routine, arguments that PROLOG was not supposed to get. Note that it doesn't fetch CONST or VAR arguments, just their locations. SETVAR can also be used directly to store out VAR arguments. These macros use the %OUT pseudo-op to report on what they're doing. This is necessary, because ASM-86 macro-expansion is fairly slow on the PC. This makes it easier to catch errors in calling sequence specifications.

Speaking Other Languages

These macros should be usable with many languages other than Pascal-86 with minor changes. In fact, there are only three aspects of an 8088 compiler's argument-passing conventions that are likely to vary from this: stack argument order, the context saved during routines, and where return values are put.

Pascal-86, BASIC, and many other compilers put arguments on the stack as they're evaluated (left-to-right) so that the last one on becomes the first to be popped off. This is the major complicating influence on the PASCAL.MAC code; in particular, it's the reason ARITY has to be computed before any argument-passing code can be generated. Lattice C, on the other hand, pushes its arguments in reverse order. This allows them to be accessed in a more natural way (it also helps that C has only value arguments). The analog of PASCAL.MAC for Lattice C is thus simpler, and is left as an exercise for the reader.

Most 8088 compilers require only BP to be preserved during subroutine execution (the instruction set was designed in such a way that BP is the only reasonable choice for argument frame pointer). Thus the PUSH BP in PROLOG and POP BP in EPILOG should be sufficient. If a compiler you're using requires more, simply add PUSH and POP instructions adjacent to the ones already there in the macro. Almost all compilers use their hardware's accumulator (AL/AX on the 8088) to pass back return values. Only MOVACC should need to be modified if you run into an exception.

Macros offer a practical way of automating the interface between compiled languages and assembly code. They enable you to keep your application logic in a development language while having maximum control of the machine.

Assemblers + Macros vs. Macro-assemblers

The ASM-86 macro language is powerful, but also clumsy and poorly designed in spots. Why isn't the design cleaner? The main reason is simple historical inertia. Most assemblers have been written by people such as hardware developers—people who are not primarily language designers and tend to be very conservative in their methods. Their traditional way to write a macroassembler is to do the code generators and symbol-table maintenance first, then graft a macro language on top of it or as a pre-processing stage. Most of the resulting macro languages have been afterthoughts thrown together to support a particular narrow set of features (often one copied from a previous assembler).

It's actually easier and better to build the macro language first. Assembler op codes and many data pseudo-ops can then become macros that take their operands as arguments and expand into calls to one of a small handful of machine-code generators, one for each instruction class. The remaining pseudo-ops can "expand" to nothing, manipulating the symbol table as a side-effect. The macro expansion process supplies the entire control structure of the assembler's first pass, resulting in a tight, clean, and well-integrated design. The macro features will become terse and effective, because the assembler writer will be using them all through the expansions.

Many cross-assemblers (i.e., assemblers that generate code for a different processor than the one they run on) are built this way, as are a few mainframe and minicomputer assemblers. As micro-based software tools become more sophisticated this situation will probably change.

— Eric Raymond

Listing 1: PASCAL.MAC

```
        .XLIST
;*******************************************************************;
;                                                                   ;
;PASCAL.MAC                                                         ;
;(C)(P)Copyright 1983 by Eric S. Raymond                            ;
;          These macros are useful for generating ASM-86 routines that ;
;       do stack-based argument handling, and can thus be treated like ;
;       Pascal-86 or BASIC routines once declared in an interface or  ;
;       EXTERNed to. Note that they must be PUBLICed and live in a    ;
;       SEGMENT PUBLIC PARA 'CODE' to be accessible to the linker.    ;
;          These macros should work correctly with any compiler that  ;
;       a) only requires BP to be saved during subroutine calls, and  ;
;       b) pushes arguments left to right (last given is last pushed). ;
;                                                                   ;
;I) General service routines                                        ;
;       To generate a routine with a given profile of value and VAR   ;
;       args and a given service routine, write the following;       ;
;                                                                   ;
;[name] PROC                                                        ;
;       PROLOG  <arg1, arg2,...argn>, tr                            ;
;       [service code]                                              ;
;       EPILOG  reg                                                 ;
;[name] ENDP                                                        ;
;                                                                   ;
;       If A stands for an accumulator name, argk may have the form  ;
;          A  -- argument k is a value argument to be moved to A     ;
;          #A -- argument k is a CONST argument (input only)          ;
;          *A -- argument k is a VAR argument (output only)           ;
;          @A -- argument k is a VAR argument (input and output)      ;
;       For these four cases, PROLOG fetches argument k to A and EPILOG ;
;       automatically stores A to it (if it's VAR).                  ;
;          If argk has none of these forms, it is simply equated to k ;
;       in the assembler's symbol tables, and can be used with GETVAL, ;
;       GETVAR, and SETVAR to give the effect of named arguments.    ;
;          If a register reg is specified, that register will be loaded ;
;       into AL or AX (depending on length) just before exit and Pascal ;
;       will see it as a return value. If reg is CY, AL will be loaded ;
;       with 1 or 0 as the carry flag is on or off just before exit.  ;
;       Since the stack loads don't change the state of the flags, AL ;
;       may pass out a VAR argument as usual before this.             ;
;          By default SI is used as a scratch register for locations of ;
;       VAR arguments. This will lose if a VAR or CONST argument occurs ;
;       after SI in the argument list. The optional second argument tr ;
;       of PROLOG may be used to specify another scratch register; it ;
;       may be SI, DI or BX and is passed to GETVAR and SETVAR.       ;
;                                                                   ;
;II) GETVAL, GETVAR and SETVAR                                      ;
;       The macros GETVAL reg, k and GETVAR reg, k will load a register ;
;       from the kth value or location argument respectively. The macro ;
;       SETVAR k, reg will store REG to the kth by-location argument. ;
;          GETVAR and SETVAR take an optional third argument which sets ;
;       the location scratch register as described above.             ;
;                                                                   ;
;III) WITH1, WITH2                                                  ;
;       The macros WITH1 and WITH2 allow any instruction that will take ;
;       the appropriate addressing mode to be applied to two operands, ;
;       one of which is a stacked argument represented by its name. For ;
;       example:                                                    ;
;          WITH2   CMP, AX, FOO                                     ;
;       expands to CMP AX, [BP+X*2] where X is the stack offset of the ;
;       argument named by FOO. WITH1 does this to its second argument, ;
;       so WITH1   CMP, FOO, AX would be equivalent to the above.    ;
;                                                                   ;
;IV) SYS function calls                                             ;
;       A macro has been included for generating interfaces to the  ;
;       PC's BIOS and DOS interrupt servers. With this macro,        ;
;                                                                   ;
;       SYS     name, int, func, <arg1, arg2,... argn>, reg, tr      ;
;                                                                   ;
;       generates source for a Pascal-accessible routine that executes ;
;       PROLOG, does an INT (int) with (func) in AH, and then does   ;
;       EPILOG. Arguments in the bracketed list are loaded and returned ;
;       as in PROLOG/EPILOG. Optional args reg and tr are as above.  ;
;          SYS will PUBLIC the generated function, though this won't ;
;       be obvious in an .XALL listing since PUBLIC generates no code. ;
;                                                                   ;
;*******************************************************************;
        .XCREF

INTFUN  MACRO   INTN, FUNCN     ;;Call a BIOS function
        MOV     AH, FUNCN       ;; with given function number
        INT     INTN            ;; and given interrupt
        ENDM

ACOUNT  MACRO   ARG                         ;;Counts arguments
        IRP     REG, <AL,AH,BL,BH,CL,CH,DL,DH,AX,BX,CX,DX,SI,DI>
        IFIDN   <ARG>, <REG>                ;;If it's a value argument
        INCT    = INCT + 1                  ;; bump the input argument count
        EXITM                               ;; then exit the IRP
        ENDIF                               ;; else continue list check
        IFIDN   <ARG>, <#&REG>              ;;If it's a CONST argument
        INCT    = INCT + 1                  ;; bump the input argument count
        EXITM                               ;; then exit the IRP
        ENDIF                               ;; else continue list check
        IFIDN   <ARG>, <*&REG>              ;;If it's an output-only VAR arg
        OUTCT   = OUTCT + 1                 ;; bump the output argument count
        EXITM                               ;; then exit the IRP
        ENDIF                               ;; else continue list check
        IFIDN   <ARG>, <@&REG>              ;;If it's a VAR argument
        IOCT    = IOCT + 1                  ;; bump the input/output arg count
        EXITM                               ;; then exit the IRP
        ENDIF                               ;; else continue list check
        LACT    = LACT + 1                  ;;It's a named argument
        ENDM                                ;;End of IRP
        ENDM                                ;;End of ACOUNT

GETVAL  MACRO   Z, N                        ;;Load Nth value arg to Z
        MOV     Z, [BP+2*(ARITY-N)+6]       ;;Move parameter to register
        ENDM                                ;;End of GETVAL

GETVAR  MACRO   Z, N, T                     ;;Load Z to Nth VAR argument
        IFB     <T>                         ;;If no transport reg specified
```

```
        MOV     SI, [BP+2*(ARITY-N)+6]  ;; fetch parameter address
        MOV     Z, [SI]                 ;; and load to where it points
        ELSE                            ;;Else transport register given
        MOV     T, [BP+2*(ARITY-N)+6]   ;; fetch parameter address
        MOV     Z, [T]                  ;; and load to where it points
        ENDM                            ;;End of GETVAR

INARG   MACRO   FML, K, TR              ;;Generate stack fetch for arg K
;;First check the null case
        IFB     <FML>                   ;;If blank,
        %OUT    K : skipped             ;; note: stack slot is skipped
        EXITM                           ;; and exit INARG
        ENDIF                           ;;End of blank check
;;Now look for a matching register argument
        ISR     = 0                     ;;No register match yet found
        IRP     REG, <AL,AH,BL,BH,CL,CH,DL,DH,AX,BX,CX,DX,SI,DI,SP>
;;Handle value arguments
        IFIDN   <FML>, <REG>            ;;If it's a value argument
        ISR     = 1                     ;; note that it matched
        GETVAL  REG, K                  ;; fetch it
        %OUT    K : VAL REG             ;; and show it in the listing
        EXITM                           ;; then exit the IRP
        ENDIF                           ;; else continue list check
;;Handle CONST arguments
        IFIDN   <FML>, <#&REG>          ;;If it's CONST
        ISR     = 1                     ;; note that it matched
        GETVAR  REG, K, TR              ;; fetch Kth location arg
        %OUT    K : CONST REG           ;; and show it in the listing
        EXITM                           ;; then exit the IRP
        ENDIF                           ;; else continue list check
;;Handle two-way VAR arguments
        IFIDN   <FML>, <@&REG>          ;;If it's VAR
        ISR     = 1                     ;; note that it matched
        GETVAR  REG, K, TR              ;; fetch Kth location arg
        %OUT    K : VAR REG             ;; and show it in the listing
        EXITM                           ;; then exit the IRP
        ENDIF                           ;; else continue list check
;;Handle output VAR arguments
        IFIDN   <FML>, <*&REG>          ;;If it's an output-only arg
        ISR     = 1                     ;; note that it matched
        %OUT    K : VAR REG (out only)  ;; show it in the listing
        EXITM                           ;; then exit the IRP
        ENDIF                           ;; else continue list check
        ENDM                            ;;End of IRP
;;If no matching register arg, equate name to arg number
        IFE     ISR                     ;;No register argument match
        FML     = K                     ;;Equate name to arg value
        %OUT    K : FML = K             ;;Report the action
        ENDIF                           ;;End of symbol check
        ENDM                            ;;End of INARG

PROLOG  MACRO   ARGS, TR        ;;Process input arguments
        .XCREF                  ;;Don't need generated code to be CREFed
        ARITY   = 0             ;;Start with 0 total arguments
        INCT    = 0             ;;Start with 0 input args
        OUTCT   = 0             ;;Start with 0 output args
        IOCT    = 0             ;;Start with 0 input/output args
        LACT    = 0             ;;Start with 0 named arguments
        IRP     X, <ARGS>       ;;Count the flavors of arguments
        ARITY   = ARITY + 1     ;; ARITY counts all four kinds
        ACOUNT  X               ;; Now count the individual kinds
        ENDM                    ;;End of argument count loop
        PUSH    BP              ;;Save that frame pointer
        IF      INCT+IOCT+LACT  ;;If there are input args
        MOV     BP, SP          ;; set up for stack access
        C       = 0             ;; initialize argument count
        IRP     X, <ARGS>       ;; and loop through the argument list
        C       = C + 1         ;; using C to count from 1 to ARITY
        INARG   X, %C, TR       ;; generating stack fetches as we go
        ENDM                    ;;End of argument-list processing loop
        ENDIF                   ;;End of 'if there are input args'
EPILOG  MACRO   REG             ;;Generate EPILOG macro
        ENDF    <ARGS>, REG, TR ;;Have it call ENDF with ARGLIST
        ENDM                    ;;End of generated macro
        .CREF                   ;;Restore CREF
        ENDM                    ;;End of PROLOG

SETVAR  MACRO   N, Z, T                 ;;Store Z to Nth VAR argument
        IFB     <T>                     ;;If no transport reg specified
        MOV     SI, [BP+2*(ARITY-N)+6]  ;; fetch parameter address
        MOV     [SI], Z                 ;; and load to where it points
        ELSE                            ;;Else transport register given
        MOV     T, [BP+2*(ARITY-N)+6]   ;; fetch parameter address
        MOV     [T], Z                  ;; and load to where it points
        ENDM                            ;;End of SETVAR

OUTARG  MACRO   K, FML, TR              ;;Gen stack load for Kth VAR arg
        IFNB    <FML>                   ;;If blank, do nothing
        IRP     REG, <AL,AH,AX,BL,BH,BX,CL,CH,CX,DL,DH,DX>
        IFIDN   <FML>, <*&REG>          ;;If it's an output-only arg
        SETVAR  K, REG, TR              ;; store to its location
        EXITM                           ;; then exit the IRP
        ENDIF                           ;; else continue list check
        IFIDN   <FML>, <@&REG>          ;;If it's a VAR argument
        SETVAR  K, REG, TR              ;; store to its location
        EXITM                           ;; then exit the IRP
        ENDIF                           ;; else continue list check
        ENDM                            ;;End of IRP
        ENDIF                           ;;Skip if <ARG> is blank
        ENDM                            ;;End of OUTARG

MOVACC  MACRO   REG                     ;;Gen code to move REG to AL/AX
        %OUT    REG value returned      ;;Show it in the listing
        IFDIF   <RETREG>, <AX>          ;;Skip the rigamarole if it's AX
        IFDIF   <RETREG>, <AL>          ;;  likewise if it's AL
        IRP     X, <AH,CH,DH,BH,CL,DL,BL>       ;;Try 8-bit registers
        IFIDN   <REG>, <X>              ;;If REG is one
        MOV     AL, REG                 ;; then move it to AL
        EXITM                           ;; then exit the IRP
        ENDIF                           ;; else try the next one
        ENDM                            ;;End of 8-bit register IRP
        IRP     X, <CX,DX,BX,SI,DI,BP,SP>       ;;Try 16-bit registers
        IFIDN   <REG>, <X>              ;;If REG is one
        MOV     AX, REG                 ;; then move it to AX
        EXITM                           ;; then exit the IRP
        ENDIF                           ;; else try the next one
        ENDM                            ;;End of 16-bit register IRP
        IFIDN   <REG>, <CY>             ;;Should carry flag be returned?
        XOR     AL, AL                  ;; If so, zero AL
        RCR     AL                      ;; and rotate in the carry bit
        ENDIF                           ;;End of carry bit processing
        ENDIF                           ;;Skip here if RETREG was AL
        ENDIF                           ;;Skip here if RETREG was AX
        ENDM                            ;;End of MOVACC

ENDF    MACRO   ARGS,RETREG,TR  ;;Gen stack loads and RET for routine
        .XCREF                  ;;Don't need cross-referencing here
        IF      OUTCT + IOCT    ;;If there are output arguments
        MOV     BP, SP          ;; set up for stack access
        C       = 0             ;; initialize arg ctr
        IRP     X, <ARGS>       ;; and loop through it,
        C       = C + 1         ;; using C to count from 1 to ARITY
        OUTARG  %C, X, TR       ;; generating stack loads as we go
        ENDM                    ;;End of argument list processing loop
        ENDIF                   ;;Now handle the return
        IFNB    <RETREG>        ;;If a return reg has been specified
        MOVACC  RETREG          ;;  generate code to move it to AL or AX
        ENDIF                   ;;skip here if RETREG was blank
        POP     BP              ;;Restore frame ptr
        RET     2*ARITY         ;;Clean args off stack
        %OUT                    ;;Make spacing blank line in listing
        .CREF                   ;;Restore cross-ref'ing for next routine
        ENDM                    ;;End of ENDF

WITH1   MACRO   OP, K, ARG              ;;Apply OP to
        OP      [BP+2*(ARITY-K)+6], ARG ;;Kth stack entry & ARG
        ENDM                            ;;End of WITH1

WITH2   MACRO   OP, ARG, K              ;;Apply OP to
        OP      ARG, [BP+2*(ARITY-K)+6] ;;ARG & Kth stack entry
        ENDM                            ;;End of WITH2

SYS     MACRO   NAME, INTN, FUNCN, ARGS, REG    ;;Gen SYS call interface
        %OUT    NAME            ;;Let user know we're here
        PUBLIC  NAME            ;;Make sure proc is accessible to Pascal
NAME    PROC    FAR             ;;Start of generated procedure
        PROLOG  <ARGS>          ;;Count & fetch input arguments
        INTFUN  INTN, FUNCN     ;;Call the interrupt function
        EPILOG  REG             ;;Call the macro generated by PROLOG
NAME    ENDP                    ;;End of generated procedure
        ENDM                    ;;End of SYS

        .LALL
        .CREF
        .LIST
```

Computer Crime

Three lessons from criminal law

Maximal use of the legal system often requires making legal tools that were designed for one purpose serve another; likewise, obtaining adequate comfort with a proposed project may require analysis of legal principles that at first glance seem wildly inapposite. What follows are recent developments in criminal law that may apply to computer users even if they don't consider themselves criminals. And so: a warning, a tool, and a marketing survey.

A Warning

Many computer stores offer electronic bulletin boards at no cost to their customers. According to a recent survey (I called the owner of a store), such boards are great for public relations, require no hardware that wouldn't be in stock anyway, take little attention, and are risk-free as long as comments about third parties are mildly edited.

My survey respondent, however, had not seen a message on the local board alleging that the operator was served with a search warrant and his system seized "because of a message that had been left, unknown to [the operator], on one of the public boards." More details were provided in the *Los Angeles Times* report of the incident. According to the *Times*, an AT&T credit card number had been posted anonymously on the board. Pacific Bell obtained a search warrant and seized both hardware and the disks containing the bulletin board messages. A California statute makes it a misdemeanor to publish a credit card number with the intent or reasonable knowledge that it will be used to avoid phone charges.

Within the same month, TRW Information Systems reported that a password to its credit files had been posted on an electronic bulletin board. The bulletin board has not yet been located, but TRW has changed its password.

If either systems operator is ever charged, a court will have to resolve hard questions—is the operator an aider and abettor if his board is used to facilitate criminal activity, or is he simply a passive conduit like the phone company? If he could be considered an aider and abettor, then where is the line drawn? Hasn't the author of the communications package helped, too? What about the manufacturers of the modem and computer?

The court would have to decide whether systems operators should be censors of the contents of their users' communications and whether users of electronic communications have any right to privacy of their communications.

A Tool

Title 19 1526(a) of the United States Code prohibits importing merchandise into the United States "if such merchandise, or the label, sign, print, package, wrapper, or receptacle" bears a federally registered trademark that has been filed with the Treasury Department. Title 19 1526(e) provides for the seizure of merchandise bearing counterfeit marks. As part of its effort to protect the Apple logo and copyrights, Apple Computer registered with U.S. Customs (an agency of the Treasury Department) and provided technical assistance and cooperation in detecting illegal imports. The efforts culminated in indictments of six individuals and five companies, and, to date, one jail sentence. IBM has recently instituted a similar program.

A Marketing Survey

The American Bar Association didn't set out to do a marketing survey—it wanted to know how the Fortune 500 and several specific industries and government agencies were affected by and dealing with computer crime. In the process, however, it produced perhaps the best marketing survey to date on the potential demand for computer security products and services.

The survey's purpose was to investigate "the nature of computer crime, its causes, its perpetrators, its victims, its effects, and how its occurrence can be prevented or diminished"—a tall order for 283 responses to a 12-page survey.

Computer crime, as defined in the American Bar Association sur-

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vey, includes "criminal activities directed *against* computers and their components, criminal activities which use computers or their components as *instruments* to perpetrate crime, and other activities involving computers which, while they may not constitute 'crimes' in the strict legal sense, nevertheless amount to abuse which perhaps should be declared illegal."

Seventy-two respondents reported having sustained, in the aggregate, "known and verifiable losses . . . during the last twelve months" of between $145 million and $730 million (the large gap results from the wording of the survey, which asked for estimates of ranges of losses). On the other hand, 125 respondents reported no "known and verifiable losses," and 78 reported having no way to tell.

An overwhelming majority of the survey respondents said that the responsibility for controlling computer crime rested with the private sector rather than with the government, and only a small percentage said that the responsibility was that of the manufacturers. Again by a wide margin, the "most effective means of preventing and deterring computer crime" was deemed to be "more comprehensive and effective self-protection by private business."

The ABA survey certainly dispels any doubt about the existence of an enormous market for computer security services and products. Marketing people should be very interested in the following statistics (the whole report is available for $5 from the ABA, Section of Criminal Justice, 1800 M Street, N.W., Washington, D.C. 20036):

1. *The most significant types of computer-related crime* (ranked by the number of respondents identifying the type as "significant"—the respondents had been asked to rate the significance of each type, but a large number of them "did not interpret the question correctly"). Those that got more than 100 votes:
   a. Use of a computer as an instrument in the theft of assets (241 votes)
   b. Destruction or alteration of data (221 votes)
   c. Use of a computer as an instrument in embezzlement (203 votes)
   d. Destruction or alteration of computer software (190 votes)
   e. Use of a computer to commit fraud against consumers, investors, or users (184 votes)
   f. Theft of computer software (178 votes)
   g. Unauthorized use of a computer for personal programming activities (140 votes)

h. Use of computer as an instrument for sabotage (123 votes)
i. Theft of raw output data (110 votes)

2. *The most common crimes in which a computer, its components, or its output was the object of the crime* (ranked by number of occurences during the most recent 12-month period):
   a. Thefts of computer software (45 votes)
   b. Thefts of computer hardware (43 votes)
   c. Destruction or alteration of data (23 votes)
   d. Destruction or alteration of computer software (23 votes)
   e. Thefts of raw output data (22 votes)
   f. Thefts of input data (12 votes)
   g. Destruction or alteration of computer hardware (10 votes)
   h. Thefts of coded output data (7 votes)

3. *The most common perpetrators (where known):*
   a. A computer programmer or "software personnel" (67 votes)
   b. A nonsupervisory computer operator (42 votes)
   c. Nonsupervisory personnel not directly involved with computers (40 votes)
   d. An individual with no prior relationships with the organization (37 votes)
   e. An outside consultant (22 votes)
   f. A computer operations supervisor (22 votes)
   g. An executive or manager not directly involved with computers (21 votes)
   h. A competitor (16 votes)
   i. A customer or a client (11 votes)

4. *The most common crimes in which a computer was an instrument in the perpetration of a crime* (ranked by number of occurrences during the most recent 12-month period):
   a. Unauthorized use of computer for personal programming activities (63 votes)
   b. Thefts of assets, tangible or intangible (44 votes)
   c. Embezzlement (22 votes)
   d. Fraud against consumers, investors, or users (14 votes)
   e. Sabotage (13 votes)
   f. Extortion or blackmail (5 votes)

The survey notes that many respondents seemed to be asking "Why don't companies that design or manufacture computer systems pay more attention to security features in the design stage? Why don't companies (and government agencies) invest more in computer security, research, and usage?" There appears to be a large market that is waiting for companies to answer those questions.

the RTool

Experts need expert tools. The correct tool, close at hand, saves you time and gives you the leverage to get results fast.

RTool is a new concept in programming aids, a powerful set of **resident** general purpose tools that you can awaken with a single keystroke. RTool eliminates the need for manuals, scratchpaper, and printouts, saving you time when time is money. And, like any good tool, RTool is easy to use.

Use RTool to capture and save screen images, scan and load disk files, and access on-line help. Create and save keyboard macros. Submit block text to the keyboard. List, rename, and delete files. Change directories. And much more. All with a few keystrokes. Even when another program is being used.

RTool closes the loop between the keyboard, display, and disk drives, letting them communicate with each other in a simple and consistent way. Think of RTool as a set of powerful new features for **every** program you own.

Available for the PC/XT, PCDOS 1.1/2.0. Write for free literature or a demo disk ($15).
Special introductory offer: both DOS versions $149 ($158 in CA).

BitWit Software
3790 El Camino Real, #205
Palo Alto, CA 94306
415/494-2611

CIRCLE NO. 274 ON READER SERVICE CARD

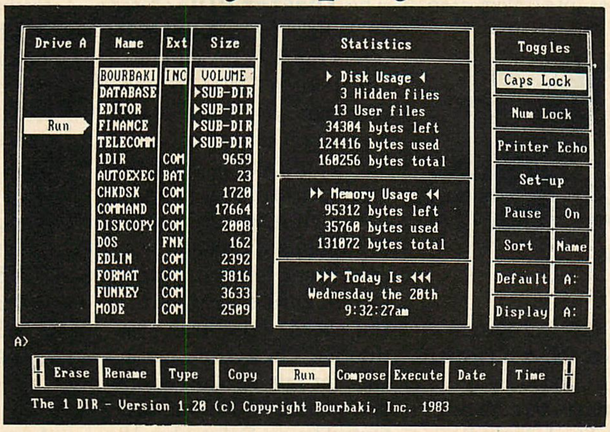
the 1dir

DIRECTORY COMMAND SYSTEM for the IBM PC & XT

Which would you prefer?

A>

THIS ← or THIS →



- Designed with the "New User" in mind
- A must for Hard Disk systems
- Compatible w/DOS 1.10 and 2.00

1dir replaces the DOS prompt with an interactive command system that eliminates the need to type commands and/or filenames to the command line. Files are accessed and programs are executed by positioning **1dir**'s scrolling FILE and COMMAND CURSORS, and pressing <ENTER>. Controlled by the arrow keys, the CURSORS are easy to use "pointers."

Suggested Retail **$95.00**

by Bourbaki Inc.™

P.O. Box 2867, Boise, ID 83701, (208) 342-5849

CIRCLE NO. 108 ON READER SERVICE CARD

PROGRAMMER'S DEVELOPMENT TOOLS AND ACCESSORIES

IBM Personal Computer Language and Utility Specialists

OPERATING SYSTEMS:

Concurrent DOS DRI	*NEW*	$350	**CALL**
Concurrent CP/M-86 DRI *Multitasking*		350	**239**
Unx-II IDS *Requires 10 MB hard disk*		895	**CALL**

Call for CP/M-86 products

***** X-Shell *****
by Standard DataCom
Bring Unix-like Capabilities to your PC
Make more effective use of your valuable programming time.
Manufacturer List $225 Our Price **$205**

LANGUAGES:

Lattice C Compiler	500	**295**
ADA-86 + Tools Janus	700	**499**
C-86 Computer Innovations	395	**319**
DeSmet C Compiler with Debugger	159	**145**
Professional BASIC Morgan Computing	345	**295**
Assembler w/Z-80 Translater 2500 AD	100	**89**

Call for Microsoft and Digital Research Products

"C" Language Starter Kit
Package Consists of:

DeSmet C Compiler w/Debugger	$159	**145**
Windows For C Creative Solutions	150	**119**
AKA ALIAS Soft Shell Technology	60	**57**
C Programming Language book by K&R	25	**20**

Retail $394, Priced Separately $341
Our Special Package Price $329!

****** STSC APL*Plus/PC ******
We can support you!
Complete demonstration package with diskette for $5, refundable with purchase. Total APL system including character generator chip.
Manufacturer List $595 **Our Price $540**

UTILITIES:

CodeSmith-86 Debugger Visual Age	$145	**129**
Profiler DWB & Associates	175	**149**
Btrieve SoftCraft	245	**205**
Windows for C by Creative Solutions	150	**119**
Translator APC *PC BASIC to MEGABASIC*	195	**175**
OPT-TECH Sort *High Performance Utility*	99	**87**
C Functions Lib. by Greenleaf Software	175	**159**
Float-87 *8087 Software Support*	125	**99**
Panel *Screen Design/Editing*	350	**234**
C-Food Smorgasbord	150	**110**
Halo *Color Graphics for Lattice, CI-86*	200	**125**
Plink-86 Overlay Linkage Editor	395	**310**
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64K MEMORY:

64-K Memory Chip Kits w/instructions	100	**55**

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Programmer's Connection
281 Martinel Drive
Kent, Ohio 44240
(216) 678-4301 (In Ohio)

"Programmers Serving Programmers"

CIRCLE NO. 226 ON READER SERVICE CARD

TECH RELEASES

Hardware, software, and other developments for the PC

PC-9 Track

HARDWARE

Further price reductions have been announced by **IBM,** which already has lowered its prices on the Portable PC and PCjr and introduced less expensive versions of the PC and PC/XT. The cost of the XT 370, model 568, was dropped by almost $500 to $6,230. Model 588, which has a 10-megabyte fixed disk, was reduced by $900 to $8,085. IBM also lowered the price of the 3270, model 2, with 256K memory, display adapter, disk drive adapter and keyboard adapter, from $4,290 to $3,785; model 4, with 384K and model 2 features plus a printer adapter, from $5,319 to $4,650; and model 6, with 384K and fixed disk adapter, from $7,180 to $6,210.

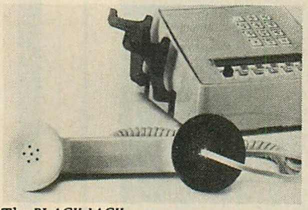
IBM
To locate your nearest authorized dealer or product center, call 800-447-4700.

CIRCLE 450 ON READER SERVICE CARD

The **Microperipheral Corporation** has announced a portable modular telephone jack attachment for computer telecommunications. Called **The BLACK JACK,** the product permits use of computerized telecommunications in locations that do not have modular (RJ11C) phone jacks. It also eliminates the loss of line sensitivity associated with the use of acoustical couplers. The BLACK JACK is constructed of rubber with a built-in circuit card and modular jack. Its unique connectors make it compatible with single- or multi-line telephone handsets. $49.95.

The Microperipheral Corporation
2565 152nd Avenue N.E.
Redmond, WA 98052
206-881-7544

CIRCLE 451 ON READER SERVICE CARD



The BLACK JACK

A magnetic tape subsystem for PCs called **PC-9 Track** has been introduced by **Alloy Computer Products.** PC-9 Track includes an intelligent interface that utilizes a Z-80 microprocessor and proprietary firmware to provide data transfer between a PC and a mainframe-compatible 9-track tape drive with an embedded formatter. The subsystem has up to 42 megabytes of back-up and working storage and provides high-speed disk-to-tape transfer at rates of .7 Mbytes per minute. $6,595.

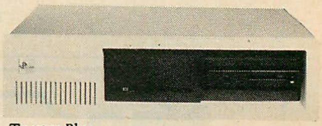
Alloy Computer Products
100 Pennsylvania Avenue
Framingham, MA 01701
617-875-6100

CIRCLE 456 ON READER SERVICE CARD

The **Toaster Plus** storage subsystem from **XCOMP** offers the 2.78-megabyte SuperFloppy Drive, which provides 3.33-megabyte (unformatted) storage capacity and 3-millisecond track-to-track performance in a compact, half-height 5¼-inch minifloppy format. A proprietary track-following servo system ensures accurate, on-track read/write head positioning. The system has a transfer rate of 500 kilobits per second. $3,995 for one SuperFloppy Drive plus 15-Mbyte (formatted) hard disk. $4,995 for one SuperFloppy drive and 31.5-megabyte (formatted) hard disk.

XCOMP
3554 Ruffin Road South
San Diego, CA 92123
619-573-0077

CIRCLE 459 ON READER SERVICE CARD



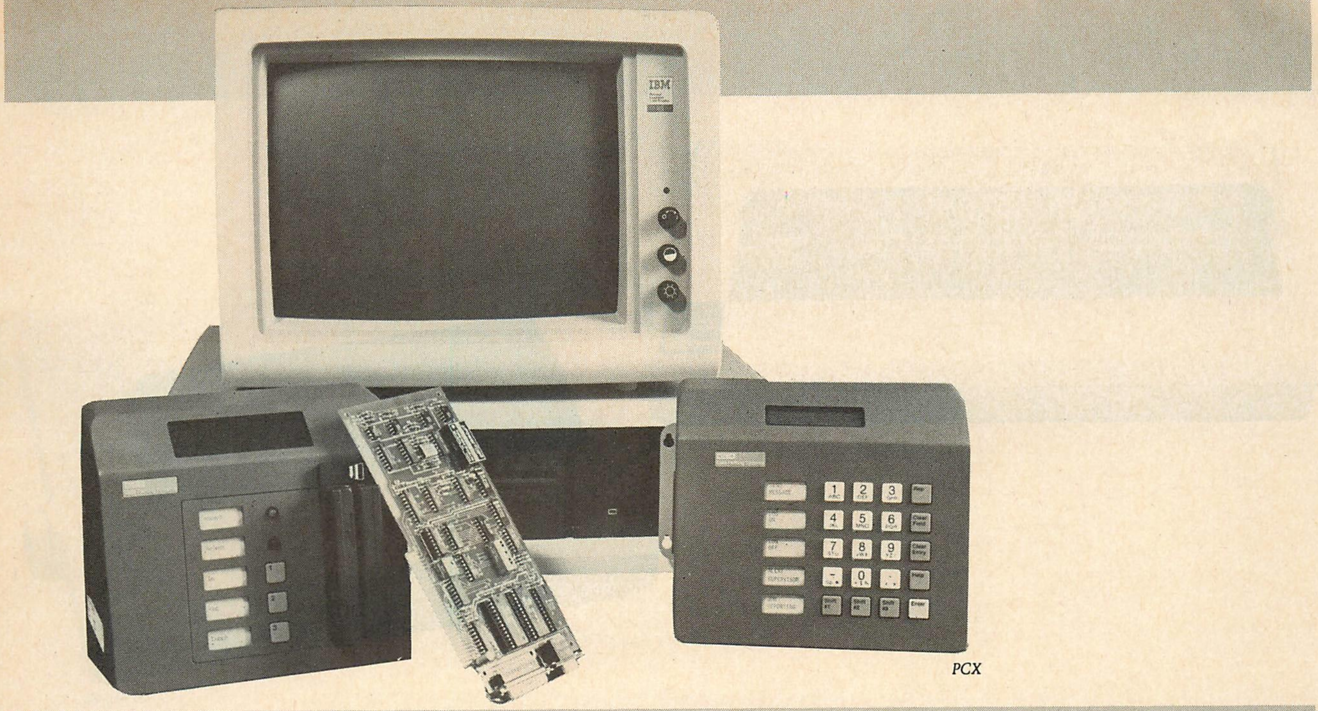
Toaster Plus

Kamerman Labs has announced a new inexpensive 10-megabyte hard-disk system that stores 12.76 Mbytes unformatted and 10 Mbytes formatted. **The Megaflight 100** uses the DOS 2.0 or 2.1 software drivers and typically requires no external power supply. The system includes a hard-disk drive, the disk controller card with plugs and cables, and a manual. $895.

Kamerman Labs
7787 S.W. Cirrus Drive
Beaverton, OR 97005
503-626-6877

CIRCLE 455 ON READER SERVICE CARD

A series of Winchester disk subsystems that features compatibility with all IBM PC, XT, and compatible hardware, software, and



PCX

peripherals has been introduced by **Data Technology Corporation.** The **TeamMate 1000 Series** includes four models: TeamMate 1110 (10-Mb internal Winchester); TeamMate 1210 (10-Mb external Winchester); TeamMate 1232 (32-Mb external Winchester); and TeamMate 1213 (10-Mb Winchester coupled with a Kodak 3.3 flexible 5¼-inch drive). All models feature full transparency with DOS 2.0 and all are FCC Class B approved. Installation takes only minutes and requires no special diskettes, software drivers, or formatting programs. Price for model 1110: $1,495; model 1210: $2,095; model 1232: $3,395; model 1213: $2,795.

Data Technology Corporation
2775 Northwestern Parkway
Santa Clara, CA 95051
408-496-0434

CIRCLE 460 ON READER SERVICE CARD

Subsystem in the TeamMate 1000 Series

The **LaserJet Printer** from **Hewlett-Packard** provides letter-quality output quietly and quickly: it registers a noise level of less than 55 decibels while printing, and it is eight times faster than a typical daisy-wheel printer. The printer is compatible with major existing software packages, such as Lotus 1-2-3, Multimate, WordStar, etc. It offers resolution of 300 by 300 dots per inch, producing print quality nearly indistinguishable from copy produced on electric typewriters. Numerous different fonts are available in plug-in cartridges; up to four typefaces can be mixed on one page. $3,495 with built-in sheet-feeder and standard RS-232-C interface.

Hewlett-Packard
3000 Hanover Street
Palo Alto, CA 94304
408-973-7648

CIRCLE 457 ON READER SERVICE CARD

The **PCX,** a personal computer expander kit, has been introduced by **NCR Industrial Systems.** PCX consists of an inexpensive terminal-communications card, a software driver, a demonstration program, and an NCR 2840 Data Collection Terminal. The terminal includes a 3-of-9 bar code wand, an alphanumeric keyboard, a 16-character display, and an optical badge reader. On the communications card are an optically isolated RS-422 port, an RS-232-C port, and a timer. With superior common-mode noise rejection and true ground isolation between the PC and the terminal network, the RS-422 driver can support as many as 32 devices at distances up to 4,000 feet. Communication takes place at 9,600 bps. An IBM with MS-DOS and R/M COBOL is required for the demonstration program. $2,500.

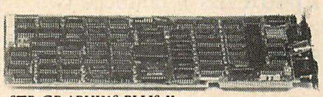
NCR Corporation
584 S. Lake Emma Road
Lake Mary, FL 32746
305-323-9250

CIRCLE 462 ON READER SERVICE CARD

A new graphics adapter board from **STB Systems, Inc—STB GRAPHIX PLUS II**—supports both RGB color and monochrome displays, switching the display to the appropriate monitor automatically. The board is configurable as a color graphics and/or monochrome/printer adapter. A full-screen monochrome graphics driver and a 16-color driver are included in the package. $495.

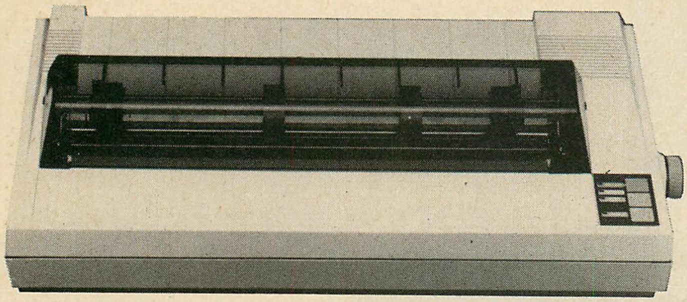
STB Systems, Inc.
601 N. Glenville
Suite 125
Richardson, TX 75081
817-732-7307

CIRCLE 452 ON READER SERVICE CARD

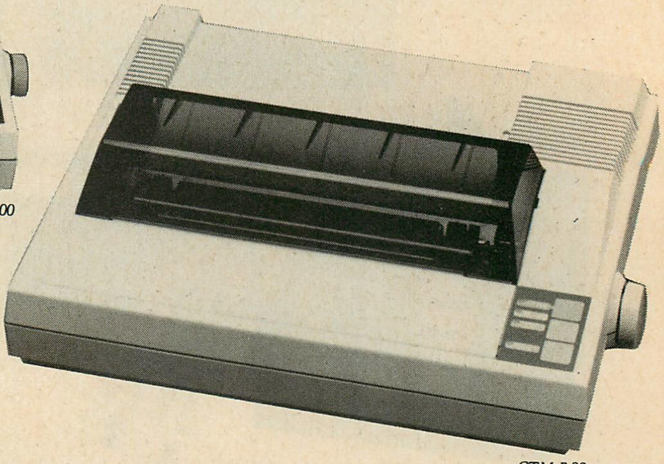


STB GRAPHIXS PLUS II

The **Peripheral Automatic Channel Emulator** (PACE) from **Data/Ware Development, Inc.** converts an IBM PC into an IBM Channel Simulator that can be used to perform factory system testing, design, or "in-field diagnostics" of IBM or IBM-compatible peripherals. PACE can operate at a variety of channel speeds, including data streaming rates (3.0 megabytes per second). Features of the package include a bus/tag 1K trace buffer—which may be set to store data pre-, post-, or mid-trigger when a preselected channel state is matched—a microprogram



CTM F-100



CTM F-80

breakpoint, and single-step capability. $12,800.

Data/Ware Development, Inc.
4204 Sorrento Valley Blvd.
San Diego, CA 92121
619-453-7660

CIRCLE 453 ON READER SERVICE CARD

Epson has announced two new dot-matrix printers designed specifically for OEMs and system integrators. The **CTM F-100** and the **CTM F-80** print at 160 CPS and feature high-resolution print characters, multiple print modes, universal power supply, extended character sets, and 20 percent greater throughput than the company's FX series. The CTM F-100 prints 136 columns; the CTM F-80 prints 80. CTM F-100: $500. CTM F-80: $370.

Epson OEM Products Division
3415 Kashiwa Street
Torrance, CA 90505
213-533-8277

CIRCLE 458 ON READER SERVICE CARD

A new data communications product from **Complexx Systems** allows three computers and/or peripherals to share a single dial-up line simultaneously. **TriMux.212** incorporates a three-channel statistical multiplexer with an auto-dial/auto-answer Bell 212A modem. Users can choose from three modes of operation. First, data from three devices can be multiplexed onto a regular dial-up call. Second, when the computers and peripherals are not using TriMux.212 as a concentrator, any of the devices can individually access and use the modem to call any other 212A modem. Finally, the three local devices can access and communicate with one another through a local data switch. $1,495.

Complexx Systems, Inc.
4930 Research Drive
Huntsville, AL 35805
205-830-4310

CIRCLE 463 ON READER SERVICE CARD

TriMux.212

Microscience International Corporation has introduced a 3.5-inch half-height Winchester disk drive with a full 10 Mb of formatted storage. The **HH-312** will interface with all micro systems using the computer's own power supply. It has an unformatted capacity of 12.76 Mb per drive and a data transfer rate of 5 Mb per second; average access time is 70 milliseconds. A proprietary closed-loop servo positioning system is used to microstep the heads to the exact center of the data track. The HH-312 uses a single PCB in place of a multiboard system; reliability is improved through the use of LSI circuitry that eliminates between-board interconnects. Under $900 for OEMs.

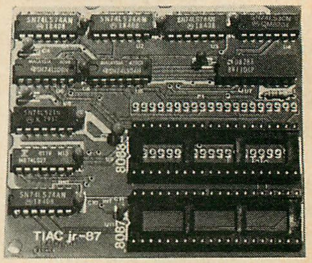
Microscience International Corporation
575 E. Middlefield Road
Mountain View, CA 94043
415-961-2212

CIRCLE 461 ON READER SERVICE CARD

An add-on circuit board called the **jr-87** has been announced by **TIAC Manufacturing, Inc.** This board permits the high-speed 8087 Numeric Data Processor to be plugged into the PC*jr*. The board does not interfere with the operation of the PC*jr*'s peripherals and does not modify the PC*jr* in any way. The 8087 operates at the same speed on the PC*jr* as it does on the PC. Software designed to run with the 8087 on the PC will run with no modifications on the PC*jr*. $89.95.

TIAC Manufacturing, Inc.
3084 Spring Street
Port Moody, British Columbia
Canada V3H 1Z8

CIRCLE 454 ON READER SERVICE CARD

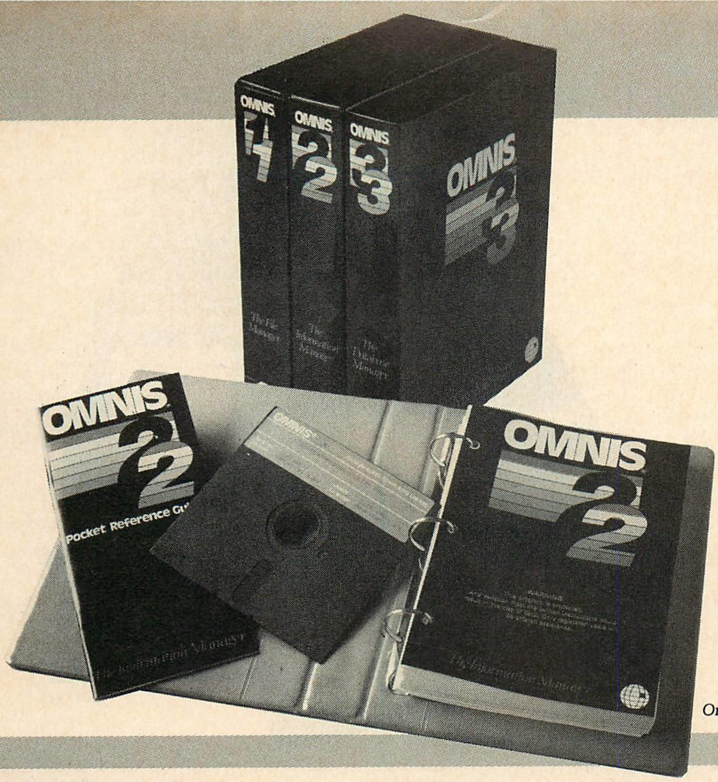


jr-87

The **Electronic Disk** from **Distributed Logic Corporation** is a fast floppy drive emulator for the IBM PC. Its maximum useful displacement is 360K, and it may be formatted as an eight- or nine-sector disk. The board plugs into any I/O slot in the PC or XT and requires no software installation. The Electronic Disk can be 62.5 times faster than a floppy disk. $995.

Distributed Logic Corporation
12800 Garden Grove Blvd.
Garden Grove, CA 92643
714-534-8950

CIRCLE 464 ON READER SERVICE CARD



Omnis 1, Omnis 2, and Omnis 3

SOFTWARE

A multitasking system has been developed for the IBM PC by **Digital Research, Inc.** The product, **Concurrent PC-DOS,** allows a PC to run four PC-DOS or CP/M application programs at the same time. It has a window capability, enabling the user to view the execution of all four applications simultaneously. Several productivity tools are included as part of the Concurrent PC-DOS package, including Print Spooler, which allows users to queue documents to be printed while other tasks are printed; and Rolodex, a sorting and searching program for lists of names and addresses. Concurrent PC-DOS has a two-user feature for use primarily as a remote dial-up link. $295.

Digital Research, Inc.
160 Central Avenue
Pacific Grove, CA 93950
408-649-3896

CIRCLE 472 ON READER SERVICE CARD

IBM has redesigned the **Technical Reference Manuals** for the PC, PC/XT, and Portable, updating all technical information on the computers' features and options. The revised manuals include three new publications—one that contains information unique to an IBM PC system, one for the PC/XT and Portable PC, and a third reference that includes information common to all PC family products, including adapters and I/O devices. With the Options and Adapters manual, IBM will provide an Update Information Service through June 1985. Prices: *The IBM Personal Computer System Technical Reference Manual*, $30; *The IBM Personal Computer XT/Portable Personal Computer Technical Reference Manual*, $30; *The IBM Personal Computer Options and Adapters Technical Reference*, $125.

IBM
P.O. Box 1328
Boca Raton, FL 33429-1328
305-998-2000

CIRCLE 466 ON READER SERVICE CARD

A series of three database programs for microcomputers has been introduced by **Organizational Software Corp.** The programs become progressively more comprehensive, and they can be upgraded as needed. **OMNIS 1, The File Manager** is designed for first-time users and is capable of handling basic information management tasks such as mailing-list maintenance, time management, and diaries. **OMNIS 2, The Information Manager** builds on the capabilities of OMNIS 1, offering multiscreen records with up to 120 information items per record, performing calculations on records, and providing search and retrieve facilities with full logical operators. **OMNIS 3, The Database Manager** supports up to 12 open files at once, operates as a relational or hierarchical database system, and generates complete turnkey systems. OMNIS 1, $95; OMNIS 2, $195; OMNIS 3, $295.

Organizational Software Corporation
2655 Campus Drive
Suite 150
San Mateo, CA 94403
415-571-0222

CIRCLE 469 ON READER SERVICE CARD

ColorScreenPrint, a software utility that increases the color capabilities of the IBM Color Printer, has been introduced by **Application Techniques.** With ColorScreenPrint, the user can choose from 16 standard colors or thousands of user-defined colors. Any graph that can be displayed on an IBM PC color display adapter can be printed at any size up to 13 inches at any position on the paper.

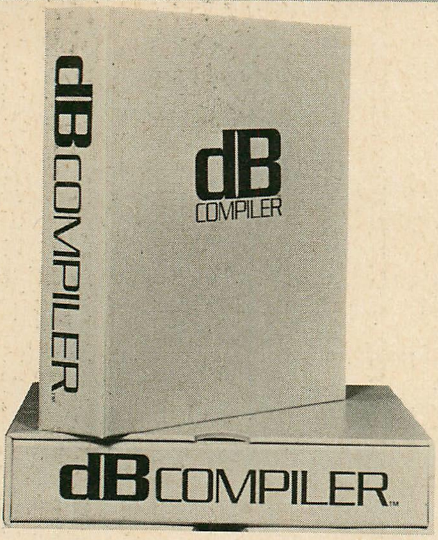
Application Techniques
80 Townsend Street
Pepperell, MA 01463
617-433-5201

CIRCLE 477 ON READER SERVICE CARD

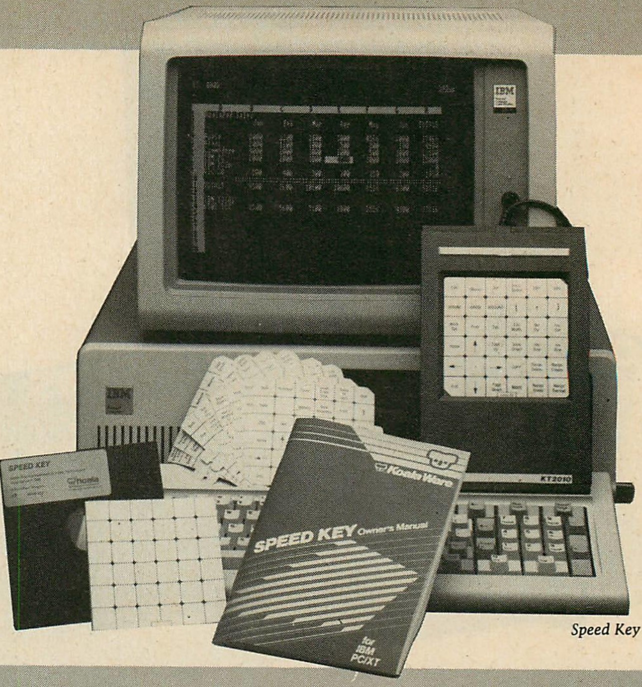
Three programs that are meant to aid photographers in the darkroom are now available for the IBM PC and PCjr. **Darkstar** provides solutions to a variety of darkroom problems, including exposure, filtration, and processing time. **Timestar** allows timing control of as many as 15 sequential periods. **Darkstar Plus** combines the capabilities of both Darkstar and Timestar. The publisher of these software programs is **f/22 Press.** Prices: Darkstar, $64.95; Timestar, $24.95; and Darkstar Plus, $89.95.

f/22 Press
P.O. Box 141
Leonia, NJ 07605
201-568-6250

CIRCLE 479 ON READER SERVICE CARD



dB Compiler

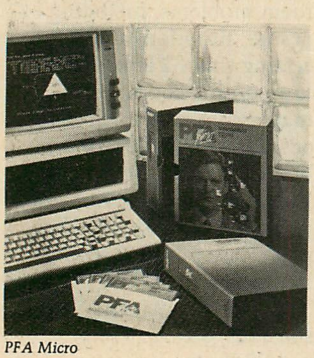


Speed Key

PFA Micro, an automated process flow analysis technique, has been called the "productivity tool for the 80s" by its producers, **Control Data Business Advisors.** The technique uses flow charts to analyze repetitive operations. The PFA Micro package consists of a facilitator's kit, $950; a training module, $450; and application software, $950.

Control Data Business Advisors
3601 W. 77th Street
Minneapolis, MN 55435
612-921-4251

CIRCLE 467 ON READER SERVICE CARD



PFA Micro

The first compiler developed for dBASE II has been announced by **WordTech Systems.** The product, **dB/Compiler,** translates a dBASE II program into code that executes without the presence of dBASE II. It compiles a dBASE II application program into modules that are smaller than the original application, saving disk space and, in some cases, executing faster. The compiled version protects source code more effectively than encryption would. dB/Compiler also has cross-linkers available so that code can be produced for different operating environments. Price: $750; cross-linkers, $350 each.

WordTech Systems, Inc.
Box 1747
Orinda, CA 94563
415-254-0900

CIRCLE 468 ON READER SERVICE CARD

Ashton-Tate and **Informatics General Corporation** have jointly introduced a micro-mainframe link for personal computer database management systems. Called **dBASE/Answer,** the product allows database information to be transferred directly from an IBM mainframe file to an IBM PC or PC/XT running Ashton-Tate database management software, such as dBASE II and III, Friday!, and Framework. dBASE/Answer will work in conjunction with a mainframe product from Informatics called Answer/DB. A typical configuration, consisting of an Answer/DB module for a single mainframe and dBASE/Answer for 50 PCs, would cost $45,000.

Ashton-Tate
10150 W. Jefferson Blvd.
Culver City, CA 90230
213-204-5570

CIRCLE 470 ON READER SERVICE CARD

Informatics General Corp.
21031 Ventura Blvd.
Woodland Hills, CA 91364
213-887-9040

CIRCLE 471 ON READER SERVICE CARD

Microsoft has released new versions of **Microsoft Pascal, FORTRAN,** and **C compilers** for MS-DOS. Enhancements to Pascal include high-speed math performance without an 8087 chip, BCD floating point arithmetic and MS-DOS 2.0 file and overlay linking options. The new FORTRAN also includes new support for large arrays and complex numbers. The latest C compiler now supports use of path names to take advantage of DOS directory structure and I/O redirection. It has expanded memory addressing capabilities. A programmer can now choose from a small-, medium-, compact-, or large- memory C compiler. Pascal 3.2, $300; FORTRAN 3.2, $350; and C 2.0, $500.

Microsoft
10700 Northup Way
Bellevue, WA 98009
206-828-8080

CIRCLE 474 ON READER SERVICE CARD

Koala Technologies Corporation has introduced a product that improves its Koala touch tablet for business applications. With **Speed Key,** the tablet becomes a custom keyboard with overlays. Each overlay contains 36 soft keys dedicated to a specific business application program—including Lotus 1-2-3, WordStar, MultiPlan, SuperCalc, VisiCalc, dBASE II, and PFS:Write. With Speed Key, the user does not have to remember lengthy commands and multiple keystrokes required by a conventional keyboard. In addition, pressing a button on the tablet will provide the user with mouse-like features. $99.

Koala Technologies Corp.
3100 Patrick Henry Drive
Santa Clara, CA 95052
408-986-8866

CIRCLE 465 ON READER SERVICE CARD

Floppiclene

Computer Control Systems has added a data, screen, and report manager to its product line. **DB-FABS** has been designed for use either in the stand-alone mode for the computer novice or in the run-time mode with a standard BASIC interpreter or compiler. The package allows the user to preset up to 16 conditions in data files, forms, and keys; other features include automatic updating of indexed files and an archival file for saving deleted records. $295.

Computer Control Systems
298 21st Terrace SE
Largo, FL 33541
813-586-1886

CIRCLE 473 ON READER SERVICE CARD

A database-management software package for PCs that is compatible with SQL/DS and Database 2 systems has been announced by **Qint Database Systems Corporation.** Using **Qint/SQL,** companies can integrate individualized data processing on PCs with their centralized databases. Qint/SQL offers database-management capabilities to microcomputer users. Three versions are available: Query, for users who need only to retrieve data from a database; Query + Update, for users who need to enter and retrieve data; and Administrator, for those concerned with the creation, maintenance, and management of database systems. Prices from $1,000 for Query to $9,000 for Administrator.

Qint Database
Systems Corporation
50 Waban Hill Road North
Chestnut Hill, MA
617-527-9329

CIRCLE 478 ON READER SERVICE CARD

A source code interactive librarian, **SET:SCIL**, has been announced by **System Engineering Tools, Inc.** SCIL can maintain any program source code, regardless of language, and it allows the user to choose any ASCII text editor. The product is the first in a new line of software maintenance tools. Soon to be released are SET:FORM, a frame-oriented "include" metaprocessor, and SET:PLAN, which will create and maintain system design documents. $695.

System Engineering
Tools, Inc.
645 Arroyo Drive
San Diego, CA 92103
619-692-9464

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In response to IBM's announcement of a local area network cabling system, **Ungermann-Bass, Inc.** has said it will offer a version of its **Net/One** that will operate on the IBM cabling system. By adding data-grade twisted-pair wire to conform to IBM's specifications, Net/One users will be able to select the most appropriate medium or combination of media for their needs while insuring compatibility with IBM products.

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CIRCLE 483 ON READER SERVICE CARD

Behind BASIC's Back

TECH NOTEBOOK 23

Some handy tricks to help you get the most from your IBM PC

DAN ROLLINS

Sometimes it is necessary to sneak behind BASIC's back to get the most from the IBM PC. Here are a few handy tricks that can be used in many BASIC programs.

This PEEK determines which monitor, color/graphics or monochrome, is currently active:

```
10 DEF SEG=&H40
20 MONO.CARD=(PEEK(&H10)
   AND &H30)=&H30
30 COLOR.CARD=(PEEK(&H10)
   AND &H30)<>&H30
40 IF NOT COLOR.CARD
   THEN . . .
```

When mid-resolution graphics mode is entered, BASIC allows no choice of color for characters displayed by the PRINT command. These POKEs provide that choice:

```
DEF SEG: POKE &H4E,KOLOR
  '** for interpretive BASIC
DEF SEG: POKE &H81,KOLOR
  '** BASCOM with /o option
DEF SEG: POKE &HB5,KOLOR
  '** BASCOM with BASRUN
```

Just set the KOLOR variable to 1, 2, or 3 and execute the relevant code.

There is a "backdoor" way to change the background color of characters printed in graphics mode: if the user POKEs the correct color address with the command KOLOR + &H80, printed characters will be XORed with the pixels that are already in place. This code sets the screen to a pseudo-inverse mode by filling it with white, then using the described POKE:

```
10 SCREEN 1
20 LINE (0,0)—(319,199),3,BF
  '** fill with white
30 DEF SEG :POKE &H4E,&H83
  '** interpretive BASIC
40 INPUT A$
  '** now experiment
50 POKE &H4E,3
```

The last POKE resets the color value to its default because the BASIC editor gets confused in this "XOR mode." While line 40 is executing, try this experiment: press the letter *a*, backspace and press *b*, backspace again and press *c*, backspace and press *a*, and finally, backspace and press *c*. The result is surprising.

Users who have a good understanding of the meaning of the bitwise XOR function should be able to figure this trick out without trying it. Incidentally, any of the four colors can be used for either the foreground or the background.

LPRINT Hints

Most users who have two parallel-interface cards and two printers have wished for a simple way to swap the printers with a software command. The following code will do exactly that:

```
100 DEF SEG=&H40
110 P8=PEEK(8) :P9=PEEK(9)
120 POKE 8,PEEK(10) :POKE
    9,PEEK(11)
130 POKE 10,P8 :POKE 11,P9
```

This procedure can be used to modify a program so that it routes all LPRINTs and LLISTs to the desired printer.

Of course, in order to keep programs as flexible as possible, use of LPRINT should be avoided. Just OPEN the desired printer as a file and use PRINT# instead of LPRINT. In addition to being more flexible, this technique allows printer output to be sent to a text file or to the screen.

BASICA version 2.0 will perform a screen dump whenever the user presses Ctrl-PrtSc. The same thing can be done without user intervention with this sequence:

```
Y!=-51973.8 :X=VARPTR(Y!)
  :CALL X
```

The secret to this sequence is that the floating-point representation of −51973.8 just happens to coincide to the opcode bytes for

```
CD05 INT   5
CB   RETF
90   NOP
```

and the CALL X transfers control to the address at which Y! is stored.

In fact, any interrupt can be invoked by using the equation Y!= −(51968.8+int.num). This has few applications, because it doesn't pass any parameters or return any values from the interrupt.

These techniques, and others like them, will help users get the most from BASIC on the IBM PC.

Dan Rollins is a software consultant and freelance writer who lives in California.

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Contact: Expoconsul International Inc., 55 Princeton-Hightstown Road, Princeton Junction, NJ 08550

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UNIX Systems EXPO/84
Los Angeles, CA
Sponsor: Computer Faire, Inc.
Contact: David Sudkin, 617-965-8350; Alan Kucheck, 415-364-4294

September 12-14
Eurographics '84
Copenhagen
Sponsor: SIGGRAPH
Contact: DIS Congress Service, Linde Alle 48, DK-2720 Vanlose, Copenhagen, Denmark

September 16-20
COMPCON Fall
Arlington, VA
Sponsor: IEEE
Contact: IEEE, P.O. Box 639, Silver Spring, MD 20901

September 20-23
New York/Userfest
New York, NY
Sponsor: Northeast Expositions
Contact: Northeast Expositions, 617-739-2000

September 24-25
World Conference on Ergonomics in Computer Systems
Los Angeles, CA
Contact: Crispin Littlehales or Rosemarie Burnett, Thomas L. Richmond, Inc., 1350 Avenue of the Americas, New York, NY 10019 212-581-4200

September 24-26
PCExpo
Anaheim, CA
Contact: PCExpo Shows, 333 Sylvan Avenue, Englewood Cliffs, NJ 07632, 201-569-8542

September 27-30
5th Annual Mid-Atlantic Computer Show and Office Equipment Exposition
Washington, D.C.
Sponsor: CompuShows, Inc.
Contact: CompuShows, Inc., P.O. Box 3315, Annapolis, MD 21403

OCTOBER

October 2-4
East Coast Computer Faire
Boston, MA
Sponsor: Computer Faire, Inc.
Contact: Dave Roth, 617-965-8350 (East Coast office); Nels Anderson, 415-364-4294 (West Coast office)

October 8-10
ACM 1984 Conference
San Francisco, CA
Contact: Karen A. Duncan, Health Information Systems, 15 Parsons Way, Los Altos, CA 94022, 415-948-3941

October 9-11
International Conference on Advances in Microprocessor Peripherals
Lausanne, Switzerland
Contact: Secretariat des Journées d'electronique et de microtechnique, Departement d'Electricité—EPFL, Chenin de Bellerive 16, CH-1007 Lausanne, Switzerland, 41-21-471111

October 15-17
4th Symposium on Reliability in Distributed Software and Database Systems
Silver Spring, MD
Sponsor: IEEE Computer Society, in cooperation with ACM
Contact: IEEE Computer Society, P.O. Box 639, Silver Spring, MD 20901, 301-589-8142

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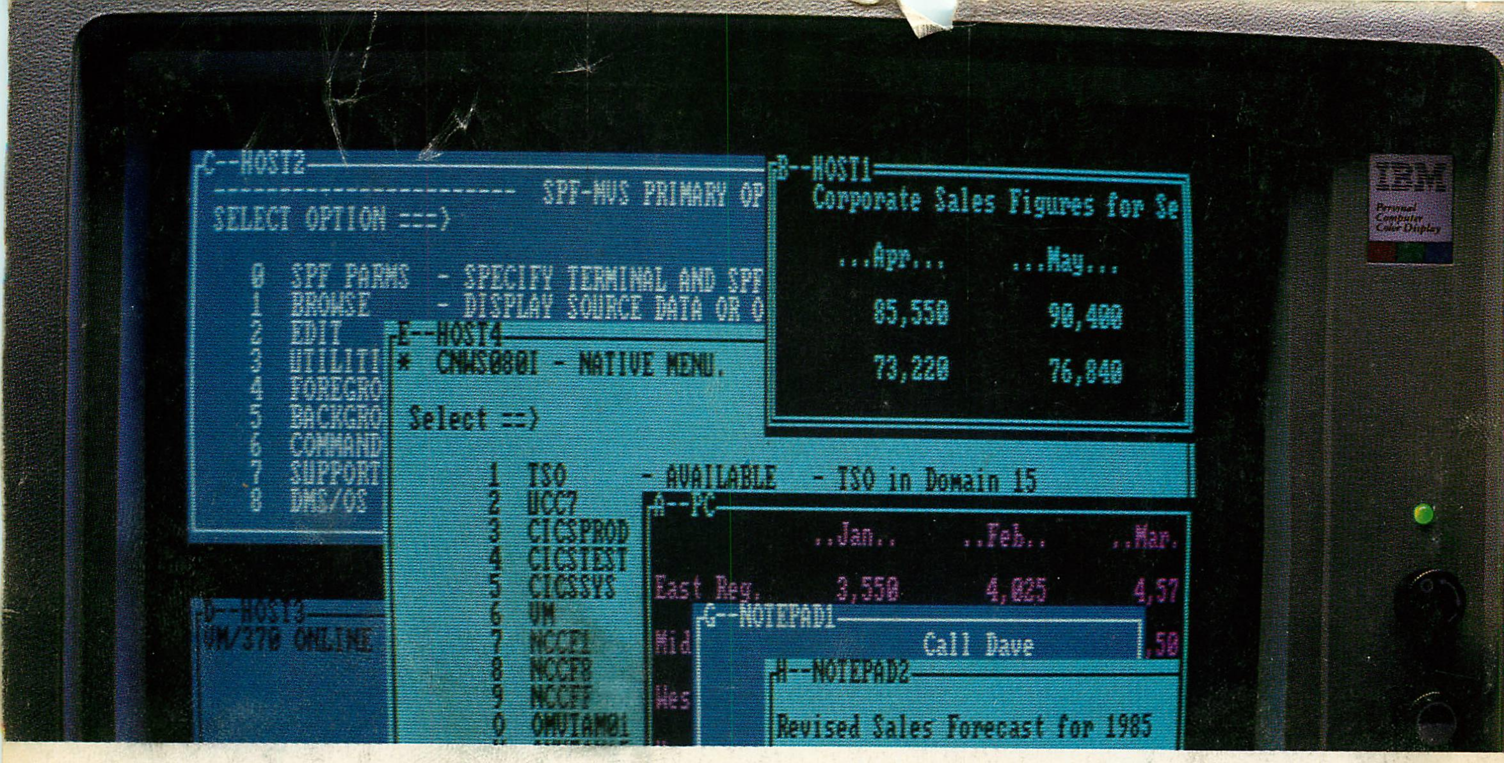

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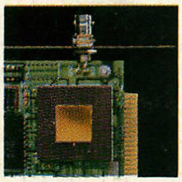

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